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Making Gray Iron Art Work

How Ornamental Castings Requiring Absolute Conformity to Pattern and Surfaces Suitable for Plating or Polishing Are Made

By E C Kreutzberg

ART collections frequently include among their most interesting and valuable specimens, exceedingly intricate grille work, lace and other patterns cast in gray iron. To the lover of art they take rank as the super-product of the Michael Angelos, Whistlers and Rodins of the foundry, and the casual observer who is at all familiar with foundry practice wonders how it is possible to cast such pieces in gray iron which generally is regarded as a metal unsuitable for work in which beauty and refinement of execution predominate. Gray iron castings of this character are liable to be regarded as the product of artistic genius rather than that of a thorough understanding of all of the many elements which enter into molding and melting and skill of a high order in utilizing this knowledge. As a matter of fact, the production of such castings requires no genius unless it is considered that genius is only infinite capacity for attention to detail, and they can be produced in any foundry where knowledge and skill are of a sufficiently high order. The truth of this statement is proved by the fact that castings which require utmost perfection in detail, which must conform without blemish to intricate patterns, which must be perfectly run despite the contiguity of thin and heavy sections, and which embody all the features of art castings, are being produced in gray iron for ordinary commercial purposes on a constantly increasing scale.

The painstaking attention to all details and the carefully selected raw materials which are necessary to produce such castings naturally contribute toward a higher manufacturing cost than is usual in foundries. As a result, the plant which engages in fine work must concentrate its efforts along this line, since it would not prove profitable to extend the output to the ordinary run of castings.

The accompanying illustration showing molds selected at random from the heat of a single day at the Edwin A. Moore Iron Foundry, Reading, Pa., indicate the possibilities of gray iron when applied to fine ornamental castings, and castings requiring microscopic accuracy. This plant, which specializes successfully in work of this character, produces castings weighing from one ounce up to 500 pounds, and its output is limited entirely to pieces which require absolute conformity to pattern and a perfect surface suitable for plating or polishing. To such fine limits does the work gage, that the company guarantees all castings, even where thin sections, 2 x 18 inches and scant ⅛-inch thick, are involved, to show a deviation from perfection of less than 0.007-inch. It further guarantees that the castings it produces may be machined at a cost of 60

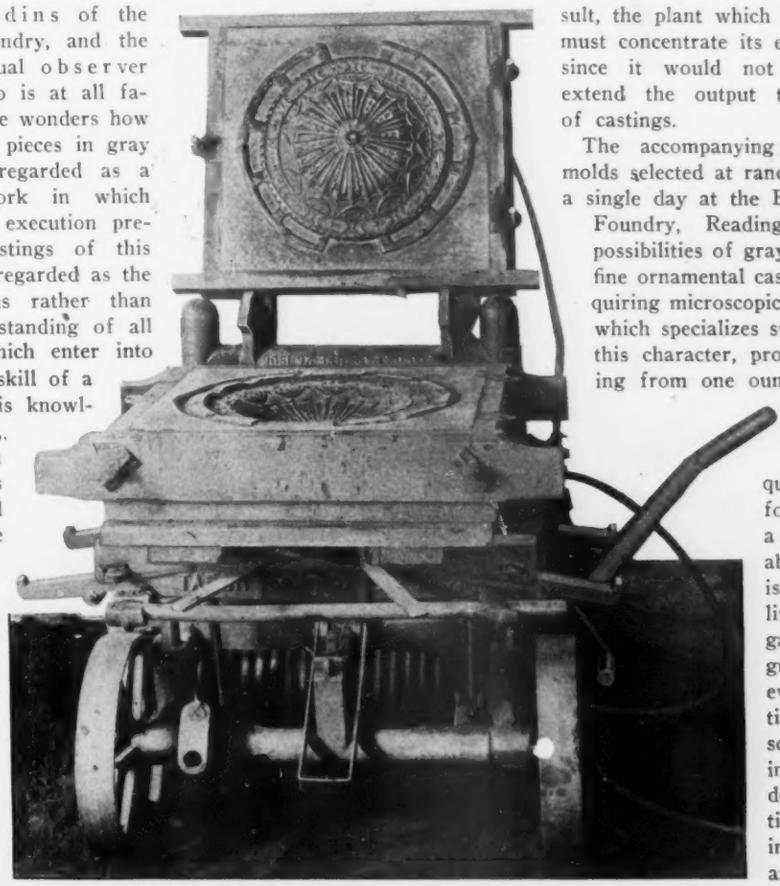

FIG. 1—MOLDING DRAG SECTION OF ORNAMENTAL DOME MOLD ON ROLL-OVER MACHINE

FIG. 3—MOLD FOR LIGHTING FIXTURE IN WHICH ORNAMENTAL DETAIL IS SO FINE AS TO PRECLUDE THE USE OF ORDINARY GATES

FIG. 5—MOLDING AN AUTOMOBILE IGNITION SYSTEM CASTING IN WHICH THIN SECTIONS AND SCREW HOLES AT CORNERS, PRESENT UNUSUAL DIFFICULTIES

FIG. 2—MOLD AND PATTERNS FOR AN AUTOMOBILE IGNITION SYSTEM CASTING IN WHICH HEAVY LUGS ARE POURED THROUGH EXCEEDINGLY THIN SECTIONS

FIG. 4—MOLD FOR PYROMETER CASE CASTING IN WHICH THIN WALLS AND LUGS CAUSE TROUBLE

per cent as compared with the machining cost of similar castings made elsewhere.

The output of the Moore foundry includes dental castings, small complex parts of adding machines, parts for typewriters, moving picture, textile and other machines, all kinds of art work such as door knockers and lighting fixtures, etc. With the exception of two molding machines, hand-ramming is practised exclusively, both on the floor and on the bench. This is due to the necessity, particularly exigent in this shop, for ramming some portions of the molds harder than others. In addition to ramming, the condition of the sand, the methods of venting the molds, the location of the gates and the correct use of facing all are given careful attention, since it has been found by careful study that most of the discount results from poorly-designed and constructed molds. The mixture and melting of the iron also receive careful consideration. The company recently experimented with an alloy obtained by the addition of small quantities of Boron copper to gray iron, and the resulting mixture has been shown to possess high resistance to corrosion. This alloy is called "caboron metal".

Ornamental Castings

Figs 1, 6 and 10 show the molds for ornamental castings. The one illustrated in Fig. 6 is for an artistic doorholder. The rooster design must be brought out sharply since the casting later receives a decorative treatment which brings out all defects. The output is 50 molds per day and the discount averages 8 to 10 per cent, due largely to washing and cutting of the sand, which destroys the detail of the surface. The weight of these castings, which are put up on the bench in an ordinary snap flask, is seven pounds each. Fig. 1 shows a roll-over machine on which the drag of an ornamental dome is molded and Fig. 10 is a view of another machine of the same type for making the copes. The principal requirement of this casting is that the ornamental detail, which is intricate and exceedingly regular and sharp, be brought out perfectly. The output, per day, is 15 molds and the discount is about 20 per cent, due mainly to imperfections arising from the washing and cutting of the sand. The metal in this casting is 3/16-inch thick.

Automobile Ignition Casting

Fig. 2 illustrates the mold and patterns for an automobile ignition system casting. These pieces are made four in a mold in an ordinary snap flask and the mold is poured through a circular gate having two branches to each casting. The chief difficulty encountered in making these castings arises from the necessity of maintaining several lugs.

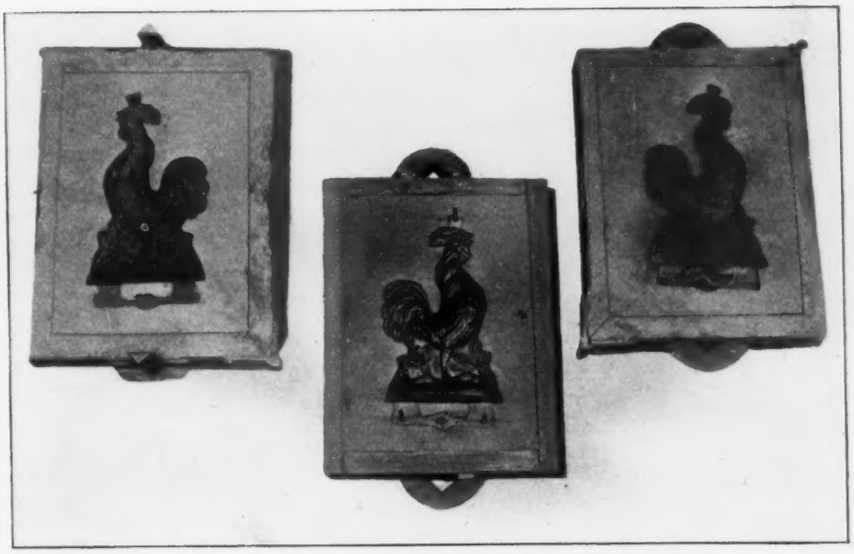

FIG. 6—ROOSTER DOOR HOLDER MOLD AND PATTERN

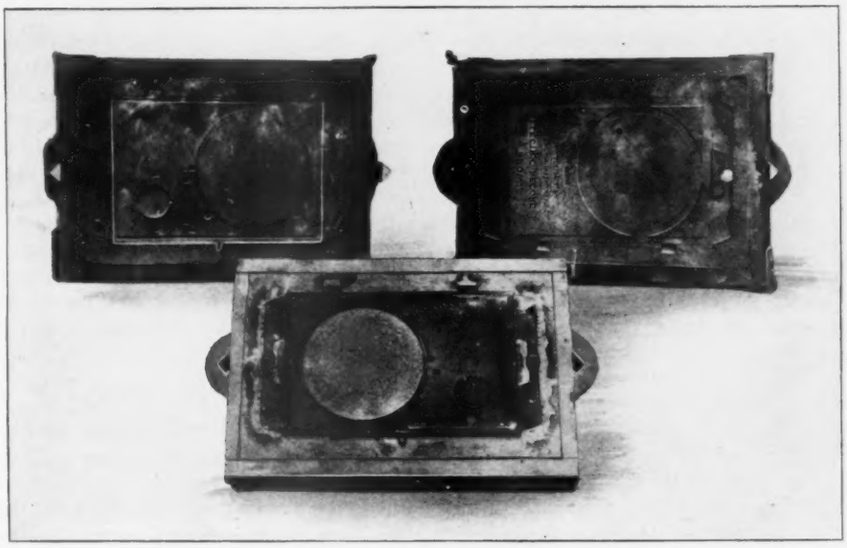

FIG. 7—PYROMETER CASE DOOR MOLD IN WHICH LETTERING AND PEBBLED MATTE MUST BE BROUGHT OUT SHARPLY, AND CASTING MUST BE ABSOLUTELY STRAIGHT

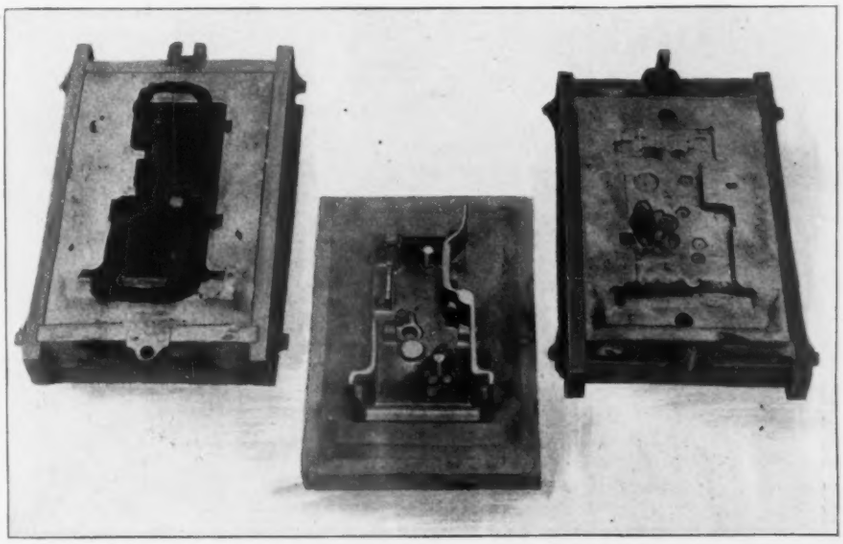

FIG. 8—MOLD FOR MOVING PICTURE MACHINE CASTING IN WHICH DIFFICULTY IS ENCOUNTERED DUE TO CONTIGUOUS THIN SECTIONS AND HEAVY LUGS AND TO THIN SAND WALLS

FIG. 4—MOLD FOR PYROMETER CASE CASTINGS IN WHICH THIN WALLS AND LUGS CAUSE TROUBLE

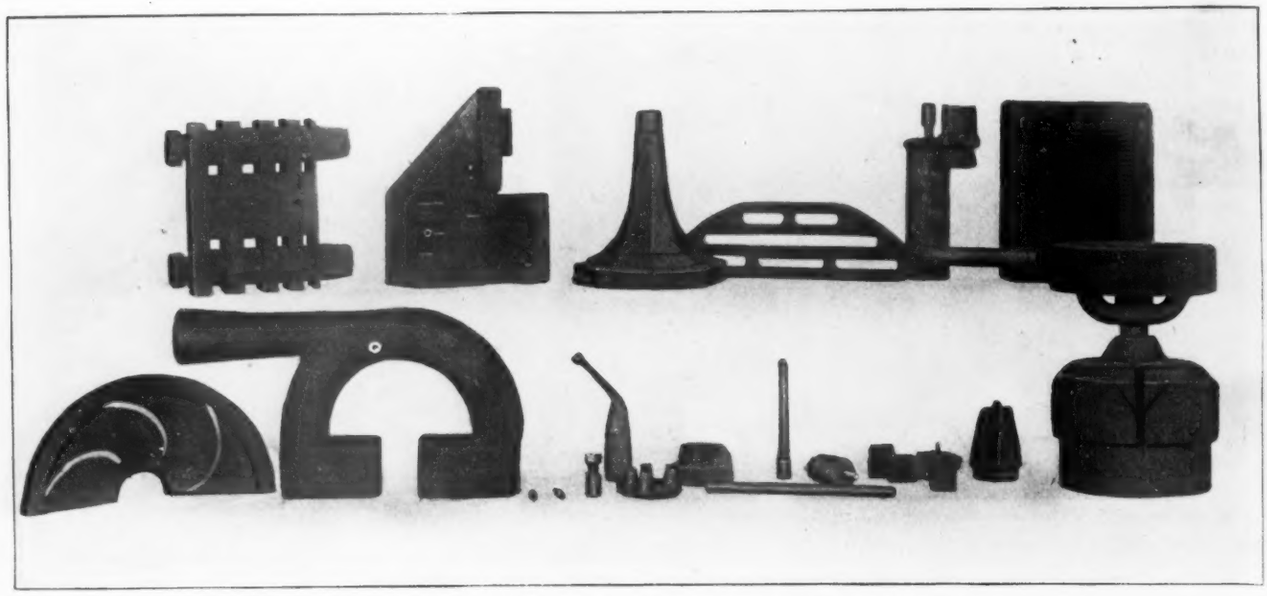

FIG. 9—TYPICAL CORES PRODUCED AT THE MOORE FOUNDRY

The heaviest lug is 1¼ inches in diameter and 1½ inches long; it is located 1¾ inches from the gate and the iron must flow into it through a section, 1/32-inch thick. A requirement of this casting is that the drill lugs, which are 3/32-inch thick, must withstand a drilling speed of 1,600 revolutions per minute; thus the iron must be free from chill. Each casting weighs ½-pound. The output per day of seven hours, is 16 molds, or 240 castings, and approximately 80 per cent of these pass inspection and are approved for shipment. Most of the discount results from short runs, due to insufficient or improper venting, or faulty condition of the sand.

Fig. 3 shows the mold for a gaslighting fixture, together with the patterns and the match-plate. Due to the sharp outlines of the ornamental details of this casting, it is impossible to use a gate of the ordinary type and therefore the mold is poured through horn gates. The output is 40 molds, or 160 castings per day and the discount is 33 1/3 per cent, due chiefly to the washing and cutting of the sand. Owing to the fact that these castings later are polished, an exceptionally smooth finish is required, but so perfectly is the pattern reproduced, that it has been found unnecessary to treat them in any other way than with the sand-blast. These castings weigh 1 pound, 5 ounces each.

Pyrometer Case Casting

Another difficult mold, shown in Fig. 4, is that for a pyrometer case. The features of this case are the depth of the draw, the thinness of the walls, the thickness of the lugs in the case, and the thinness and lengths of the lugs and the latch on the rim of the casting. The case has a depth of 3¾ inches and weighs 8½ pounds, the thickness of the walls being 3/32-inch. In making this mold, careful ramming is required, some portions being rammed hard while in other knuckling suffices. This mold is put up in three parts, a drag, a cheek and a covering cope, and it is provided with two gates. The day's heat is 18 molds, with an average of 16 good castings. Most of the discount is due to swelling of the sides and cold shot in the back of the casting.

Fig. 5 shows the mold and patterns for another automobile ignition system casting. These pieces are cast six in a mold and are put up in an ordinary snap flask. Each weighs six ounces and averages 1/32-inch in thickness, with the exception of the drill lugs, which are 3/32-inch. Despite the thin wall section, the casting must be kept soft enough so that it may be drilled by a gang drill at high speed. It must be cast absolutely true to pattern, since it is fitted with great accuracy. The discount arises chiefly from defects in the lower corners of the castings, where exceedingly fine loops are required to form screw holes. To prevent the corners from being cut and washed by the metal, it is necessary to sponge them, with the result that considerable gas is generated when the mold is poured. The condition of the sand, therefore, must be correct and the mold must be vented properly that this gas may be removed as soon as it is generated. The output is 60 molds per day, or 360 castings, and the discount averages only about 12 per cent.

Fig. 7 shows the mold for a pyrometer case door, together with the pattern and match-plate. The mold is made in an ordinary snap flask and the casting is 10 x 15½ inches, weighs 4¾ pounds and is 3/32 inch thick, with the exception of

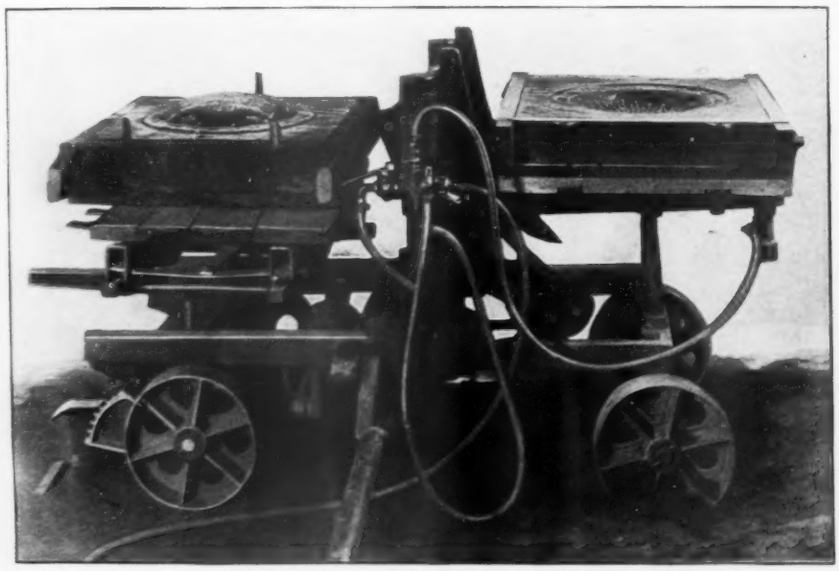

FIG. 10—MOLDING THE COPE FOR ORNAMENTAL DOME MOLD ON ROLL-OVER, DRAW MACHINE

FIG. 11—TYPICAL CASTINGS PRODUCED AT THE EDWIN A. MOORE FOUNDRY, READING, PA.

the border, which is a scant ⅛-inch. The chief requirements are that the casting be true to pattern, straight within a limit of 0.007-inch, and that the sharpness of the lettering and of the pebbled matte be unblemished. Perhaps the most difficult feature is the maintenance of the lugs on the back and the small lock loop on the edge of the casting. To produce a perfect casting, therefore, the mold must be vented with great care since considerable sponging is necessary. The daily output is 25 to 30 molds, resulting, on the average, in 20 perfect castings.

Fig. 8 shows the mold and pattern for a moving picture machine. This mold is made on the bench in an ordinary wood flask. The main features of the casting are the depth and thinness of the sections, and the presence of numerous deep lugs and bosses which are located close to each other, thus causing difficulties due to thin sand walls. The sand is exceedingly liable to wash, hence sponging is necessary, with consequent attention to venting. The castings must be absolutely square and hence care must be taken to guard against defects arising from contraction after pouring, since a good deal of freaky shrinkage is liable to result from the thin sections and the adjacent heavy lugs and bosses. The fine limits required are illustrated by the fact that a shift of any of the lugs as much as 1/16-inch is sufficient to cause the casting to be rejected. The casting weighs 12½ pounds, is 4⅝ inches deep and the walls have a thickness of 11/64-inch. The mold has a riser and is poured through two runners. Undesirable effects of contraction are eliminated by uncovering certain sections of the casting immediately after pouring, leaving the mold, as a whole, to be shaken-out after the casting has cooled.

Fig. 9 shows some of the intricate dry sand cores made at this foundry, and include cores for a motorcycle cylinder, ceiling plate, car-lighting fixture, gas-meter slot-casting, auto-ignition system casting, timing system casting, gas-heater burner, a turbine casting, punching machine and core for a valve.

Variety of Work

Fig 11 shows typical castings produced by this foundry. From left to right, the top row of castings includes a portable lamp base and column, cast gear wheels, pyrometer case, thermostat case, electric dome plate, lighting fixtures, and a rooster door-holder; the bottom row, left to right, includes a gas-fixture base, ignition system casting, adding machine frame, lighting fixture ornament, slot casting for a gas meter and a pyrometer case door.

One of the most difficult castings made at this plant is that shown in Fig. 12. This is the frame for an adding machine. This casting weighs 11 pounds, is 10½ x 18 inches, and the top slopes up to a height of 11 inches. The thickness of the metal is a scant ⅛-inch, and the casting is provided with several difficult lugs. The pattern is in two parts and is molded on the bench in a 4-part flask. The output is 12 molds per day, and the discount, which is about 25 per cent, results principally from imperfect venting, since ample provision must be made to carry off the gases generated in pouring. These are present in considerable volume, due to the necessity for thorough sponging of the mold in order to prevent washing.

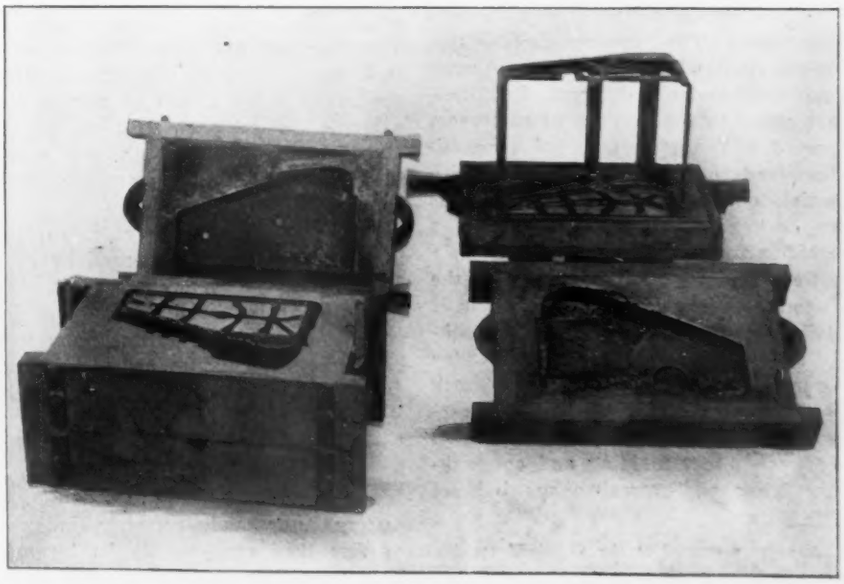

FIG. 12—MOLDING 10½ x 18-INCH ADDING MACHINE FRAME WHICH IS REQUIRED TO VARY FROM PATTERN NO MORE THAN 0.007-INCH

Essential Factors in Foundry Cost Accounting

Intelligent Bidding and Fair Competition Depend Upon a Knowledge of the Cost of Different Casting Operations

By Clinton H Scovell

TOO many foundries are being directed without adequate information coming to the executives as to the cost of the products of different kinds, or for different customers; without sufficient control of expense, or adequate information regarding the cost of unused capacity; and all too frequently, without a production plan which will enable the management to get the most out of the facilities available. This is due to the widespread belief that it is impossible, or impracticable from the standpoint of clerical expense, to have more accurate information.

There are few foundry executives, however, who doubt that they could use precise information of this kind for a more efficient conduct of their operations, if only they could get the records that they need promptly and economically. It is the purpose to point out how these results, admitted to be so highly desirable, can be secured.

Objects of Foundry Accounting

There are three principal objects to be attained by operating an adequate cost and accounting practice in a foundry. First, the management should know the costs on each line of work, and therefore the profits on the product made for the individual customer. The importance of this information will vary in different communities, and in different foundries, according to the number of customers served and the amount of competition, and therefore the accuracy with which quotations must be made (as to customers this applies only to a jobbing foundry).

Second, it is all important that the foundry management should have daily reports and weekly and monthly summaries, of the cost of foundry operations. If the volume of work is fluctuating, it is obviously necessary to watch closely the relation between direct molding and coremaking labor and miscellaneous indirect operating costs. There will naturally be daily reports showing the kind and quantity of material charged, the ratio of metal to fuel, the amount of metal poured out of the daily melt, and the proportion of good and bad castings made. Some of this is only statistical information, and some of it, as for example, the cost of spoiled castings, becomes much more significant when reduced to dollars and cents.

Third, if a foundry is asked to make individual castings which are important as to weight, difficulty of molding, coremaking, cleaning, requirements as to metal, hardness, etc., so that special attention is required at every stage, it will be desirable in such special cases to calculate the cost of individual castings. In a jobbing foundry, handling work for different customers, the character of their patterns will obviously be taken into account in quoting a price, and if that price is uniform for all the requirements of one customer, there is not much to be gained by attempting to get costs on individual castings, except occasionally to see that one or two patterns are not costing too much above the average.

But in a foundry where the work is done almost solely for the machine shop in the same business, the only kind of cost accounting beyond averages that will be of much value is one that will get costs on individual castings, or possibly on groups, like the castings for a line of pumps, for example, in contrast with a line of gasoline engines, if both are made in the same foundry and machine shop.

From this brief survey it is plain that the object to be secured by cost accounting will vary greatly in different foundries, so that what may be an obvious necessity in one plant will be a matter of indifference in another.

An adequate production scheme is one of the essentials for efficient foundry management. It is also the framework for the cost accounting.

There should be a record of all patterns on hand, properly indexed so that they may readily be located. This record should show the date, and from whom received, storage location, pattern number and how many castings are to be made from each pattern. When customers' patterns are returned, the date of the return should be noted on the pattern record before the card is removed to the transfer file.

Upon receipt of an order for castings, at least three copies of the production order can be used effectively. One should remain in the production department, filed by customers or manufacturing classification, and two copies should go forward to the foundry foreman, one for his file and one as an order for patterns. A summary of these orders is kept by the production clerk, classified by customers, and if desirable for production purposes, according to weight of castings or grade of metal. A color scheme may be used in connection with production orders, different colors representing the various weight or grade classifications. A daily analysis of this summary is made by the production clerk and foundry foreman, and the production for succeeding days determined. Postings are made to this record, crediting the good castings made each day and leaving as a balance the number of castings for each pattern yet to be made.

Distributing the Labor Charges

When new patterns are received at the foundry the gross weight of castings to be made from these patterns is calculated. By maintaining the record outlined in the preceding paragraph, the production ahead of the plant can be closely estimated.

Production orders as issued to the foundry should be given serial numbers. These order numbers can be so arranged as to indicate a customer, a class of work, a pattern, or if desirable, all three.

The labor cost will be sharply divided between direct and indirect charges. Even if the direct charges are not further sub-divided, the total payroll should be separated into cupola labor, molding, coremaking, cleaning, pattern work and carpenter shop. In most cases there should be a subdivision of molding and coremaking labor which will show the time consumed by molders and core-

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A paper presented at the Cleveland meeting of the American Foundrymen's Association, September, 1916, and adapted from C. H. Scovell's "Cost Accounting and Burden Application," published by D. Appleton & Co., New York.

makers against individual production orders (and on large work a similar division of cleaning also).

All indirect labor (except that connected with the molding, coremaking, and possibly cleaning departments) should be charged to appropriate burden centers and subsequently distributed to job cost cards on the basis of pounds of good castings made. The indirect labor associated with molding and coremaking will be charged from the labor distribution to the molding or coremaking burden centers, and applied to costs through the hourly burden rate of these centers.

Materials and Supplies

The principal material costs in a foundry are those for pig iron, scrap and fuel charged into the cupola. There is also a considerable expense for molding and coremaking supplies, brick, furnace linings and general items such as heating fuel, building and equipment repairs, etc. The disposition of these miscellaneous charges will be discussed in a subsequent paragraph.

The material charged to the cupola is the principal cost of melted metal, although the total cost of metal is composed of fixed charges on the investment on cupola equipment and raw material inventories, cupola repairs and the labor of the cupola gang. In any well run foundry there is a daily report of materials charged, and weekly and monthly summaries, from which the values of the materials consumed may be readily calculated as a charge to the cost of melted metal.

A perpetual inventory should be maintained for all materials and supplies. This does not necessarily mean that detailed stores cards should be maintained, covering all items of supplies. But separate accounts should be kept (including freight as well as purchase price and unloading costs when kept separate) for such important items as pig iron, scrap, coke, molding sand, etc. General supplies may well be grouped in a storeroom, for which one person should be responsible. The balances on hand may be checked individually as convenient. If various sections of the inventory are checked at regular intervals, a very accurate record can be maintained, so that it is possible to prepare a reliable statement of loss and gain at the end of each period without taking a physical inventory.

It is highly advisable that such supplies as nails, gaggers, etc., be kept under stores control. Large savings have been effected by requiring the foremen of the molding and coremaking departments to issue requisitions for this class of supplies, which are a charge to burden in the respective departments.

Overhead charges or burden are a very important part of the cost of product in an ordinary foundry. Foundry land, it is true, is usually cheap, and the buildings are relatively inexpensive; but repairs are high, especially to cupola and equipment, if they are to be kept in good order, depreciation is rapid, and the current charges for supervision, indirect labor, and supplies, are considerable. It is highly important that the current charges should be allocated and charged to the product accurately.

The natural divisions of a foundry are the cupola and the departments for molding, coremaking and cleaning. A large space may be devoted to pattern storage, and in some foundries, to a pattern shop and a carpenter shop for repairs.

The first burden charge to each department is for rent. In case the foundryman rents his plant from a landlord, the rent chargeable to each department can be determined easily by apportioning the total rental paid among the departments in proportion to the relative areas which they occupy in the factory. In the more common instance, where the plant is owned, the expense corresponding to rent consists of interest and taxes on the land, and interest, taxes, insurance, depreciation and repairs, and possibly heat and light on the buildings. The sum of these charges determined for each building in the plant, divided by the available floor space in each, gives a square foot factor which can be used to distribute the rent charges to departments.

The Equipment Factor

Let us now consider that we have the departments clearly indicated and with the cost of the floor space used by each properly determined. Each department is provided with certain equipment necessary for the operations which it must perform. The burden charges on this equipment will vary, because of the varying cost of the equipment, which affects interest, tax and insurance charges, and because the nature of the operations performed affects the depreciation. Charges of these various kinds are therefore based on the value and kind of equipment in each department. The sum of the rent and equipment charges is fixed whether any manufacturing operations are carried on or not, and are known as fixed charges.

The next charges are for power to drive the machinery and for repairs to keep the factory in good operating condition. The power plant should be considered as an individual unit, and the cost of generating steam and power carefully determined. The cost of operating the power plant will include, beside fixed charges, such items as labor, repairs, coal, water and supplies. Having determined the cost of power, each department using power should be charged with its correct proportion of this cost. If it is not feasible to record the power used by each department, the consumption should be estimated as closely as possible. Multiplying the horsepower hours used by the cost per hour, the power charge against each department is determined.

Handling Expense of Repairs

In a large plant the repair department should also be treated separately, and its burden known. The original estimates on the cost of repairs in departments may be made from repair department records, or from a knowledge of the repair materials purchased, the payroll in this department, and its share of the burden. When work is done for the productive departments such work should be charged to them in the same manner as it would be by an outside company. Including all the elements of cost in the repair charges puts the repair department on a fair comparative basis with outside contractors who would certainly include their burden in making estimates on the cost of work. When the charges are accumulated on the individual repair job they check the estimate in each department.

The labor cost for foremen will be part of the burden of molding and coremaking, and of the pattern shop and carpenter shop, if they are large enough to have charges of this kind. Cleaning labor may all be thrown together and assessed, with other general charges as a cost per hundred pounds on all the work done, but if the foundry is handling large castings which individually take several hours to be cleaned or chipped, these costs should be charged separately just as much as molding or coremaking labor, and in such cases the labor of foremen will be charged to burden as in other departments.

Some foundry executives may question the importance of dividing overhead or burden as above described. They may believe that average costs for metal, molding, coremaking, cleaning, etc., are all that is necessary, and where the product is very uniform, a fairly good control of foundry operations may be secured in this manner.

All foundrymen, however, recognize the widely varying labor costs for molding and coremaking on castings of different weights and different shapes. It is the difference in labor cost that attracts attention, but it takes only a little analysis to show that there is a burden on molding separate from that on coremaking. If an accurate distinction between the cost of light and heavy castings is desired, it is essential to separate the burden costs as well as the labor costs, and charge these burdens in proportion to the work actually done in the respective departments and not as a flat average over the entire output.

Collecting Casting Costs

The elements of cost in a casting are the cost of metal at the spout, and the costs of molding, coremaking and cleaning. There is overhead or burden to be reckoned in connection with all these costs, and there are certain general expenses, as for power, heat and light, and supervision that must be considered and spread in an appropriate way over the product.

These costs will be accumulated on job cards for individual production orders. It is a question of discretion as to just what a production order should cover. In most foundries it will stand for a class of product, or for an individual customer's requirements, but in some instances, as previously noted, individual castings will be made on separate production orders.

A job card should provide for the hours and amount of coremaking and molding labor, pounds of good and defective castings made, and a memorandum as to the loss through returns and allowances. The hours and amount of coremaking and molding labor will be posted from daily labor tickets and the weights of castings, both good and defective, from the daily production reports. A memorandum of loss by returns and allowances will be obtained from the accounting department as credits are issued.

The burden of the coremaking and molding departments will be applied to the corresponding labor charges, preferably on the basis of the productive hours already charged.

If the work is large, cleaning labor and burden will appear as separate items on the individual cards. Any charges for patterns, or machine work that may be done strictly as a foundry cost, will be accumulated on a separate cost card, but should be included on the cost-of-castings card under the heading of "Other Charges".

The cost of metal at the spout as accumulated in the account set up for this purpose is to be distributed to the job cards in proportion to castings made. Some managements will desire to have the material cost of metal and the cupola operating or conversion cost separately on the production orders, but if this division is made, it seems logical to go a step further and show cupola material, labor and burden all separately. The cost of the metal and the cupola operating cost are separate, of course, on the cupola report.

Just what course is adopted in this respect will depend on the view taken in regard to defective castings, and as it cannot always be known whether castings are defective as soon as they are broken out of the sand, it seems wiser to distribute all of the cupola costs to all of the castings made. Those that prove defective have a scrap value. If this is regarded as equal to the average cost of the cupola charge, the cost of the defective casting will be merely the labor and burden (and conversion cost, if stated separately) which has been incurred in their making.

The same result can be secured by distributing the cost of metal on the basis of good castings made and distributing the cupola labor, burden and fuel on the total weight of castings made, both good and defective.

A total will be obtained as to both gross weight and amount, from which the weight only of defective castings will be deducted, if the metal cost is charged on the basis of good castings. If the metal cost is on the basis of gross weight, both the weight and value of scrap will be deducted. According to either plan, this will leave the net weight of good castings, and the total cost of both good and defective, less the scrap value of the defective castings.

General Burden

To the cost, as above determined, general burden should be applied, representing miscellaneous foundry expenses, at a rate per hundred pounds. The main elements of burden in a foundry are to be recognized and distributed as charges on land and buildings, and for power and repairs, but after the best possible analysis of charges of this character, and their distribution to cupola, and to the departments of molding, coremaking, cleaning, etc., some general charges will remain for such items as general supervision, clerical labor, shipping, delivery and the costs of defective castings returned from customers (less scrap value). If the product is fairly uniform and rather small, all the costs of cleaning can be conveniently thrown in the general burden and distributed on a pound basis.

The expense for flasks and patterns, including repairs as well as fixed charges, is logically part of the molding burden, but this is sometimes thrown into general burden.

The policy of different foundries will naturally vary in respect to the cost of new patterns. In a jobbing foundry where the customers own the patterns this factor will not have to be considered, but in a foundry having its own machine shop, it will be considered part of the foundry cost. The general up-keep of patterns may fairly be included in molding burden, but the cost of new patterns should be accumulated on individual pattern orders, even if the final charges are to an expense account.

Patterns are an asset to a certain extent, and if a foundry is rapidly increasing its line, it is logical to increase the asset in patterns, but after a line has been fully established an increase in the assets on account of patterns should be made very cautiously, and practically all expense of this kind charged as maintenance.

Summarizing the Costs

To complete an adequate cost and accounting plan for a foundry, provision should be made for summarizing various records. The distribution of labor and materials and also the development of burden, have already been explained.

The total cost of the cupola will be distributed to individual production orders or job cards, according to one of the two plans previously outlined, and the total will be a credit to the cupola account and a charge to individual orders. A summary of the production orders in respect to labor and departmental burden will provide credits to the respective labor and burden accounts, and the total cost of the finished castings will be charged to an account called "Cost of Goods Sold", by individual customers if immediately shipped, or be transferred to a machine shop inventory. The foundry cost cards should provide for a convenient posting of shipments (weight and cost value), and to carry forward the remaining inventory to the operations of the next period. A few foundries maintain a stock of clean castings that have not been machined, but this is almost uniformly for the benefit of the machine shop rather than the

foundry, and the value of such raw castings is much better transferred to the raw material inventory in the machine shop, rather than carried as inventory of finished work in the foundry.

On continuous jobs, such as work for a regular customer, or on any special work that is not finished in the month in which it is started, there will be material, labor and burden costs in the succeeding period in addition to those brought forward from the previous period. The balances, both weights and cost values, determined at the end of each period (month or four weeks) are an inventory of work-in-process, and the total of the balances on the job cards should agree with the controling account in the general ledger. This bookkeeping agreement should be established as a matter of course every period, and a physical inventory should be taken and compared with the job cards from time to time as may be convenient, so that the management may be sure that the values and the weights are actually on hand.

Upon each cost card there should be provision for such information as the selling price, cost of goods sold, gross profit, loss on returns and allowances, and net profit. These items should be proved, by means of summaries, with the controling accounts in the ledger.

With an accounting plan in operation as defined in this article, the management of any foundry can have accurate costs on each class of castings made or sold, know profits on each customer, and have at the end of the month a dependable balance sheet and earnings statement. These results, moreover, can be secured with a surprisingly small amount of clerical labor beyond what is absolutely necessary for the orderly conduct of any business.

So many foundries operate in conjunction with machine shops under the same management, that it seems in order to add a word of caution that the management should always make sure that the costs of operations are equitably divided between machine shop and foundry. This is particularly important to a company that is doing jobbing work in the foundry, besides supplying castings for its own shop. The income from casting sales will naturally be set apart, but unless special care is taken, the charges applicable to the foundry will not be known and determined with equal accuracy.

A foundry that is doing jobbing work is very likely to be in competition with other foundries and while the jobbing business may be desirable to make up tonnage and work the foundry economically, any decision to take business of this kind or let it go should be made only on the basis of accurate information as to what it actually costs and what, if anything, the foundry will lose from unearned burden, if the outside work is dropped.

Cupola Charging

By W. J. Keep

Question:—We recently installed a new cupola which is lined to 40 inches and we are melting approximately 6½ tons per heat. We are using half pig iron and half scrap. Our bed charge of iron is 1,800 pounds, followed by charges of 1,500 pounds each. We would like to know what the coke charges should be for castings weighing from a few to 500 pounds.

Answer:—The weight of the castings, of course, has nothing whatever to do with the coke charge. You should charge sufficient coke to get hot iron. With such a small heat it is advisable to close the entire upper row of tuyeres. It is probable that the maker of your cupola has advised you how much coke to use on the bed. After the coke is fully lighted and all the wood is burned out, and when you begin to charge iron, the bed should extend 15 inches or a little more above the top of the tuyeres. Other charges should be in the ratio of 1 pound of coke to 10 pounds of iron. If the iron comes hotter than you require during any part of the heat, you can reduce the coke charges slightly the next day, or if the iron is too dull, the coke charges can be increased. In this way you will soon arrive at the proper charging figures. For a cupola of this size your iron charges are somewhat large, since charges of 1,000 pounds would be preferable to charges of 1,500 pounds. There is no reason for making the first iron charge larger than the others, although it seems to be common practice to do so, since the more iron you can crowd on a charge, the better the melting ratio.

Book Review

Selling Your Services; board, 176 pages, 5½ x 8¼ inches; published by The Sales Service Co., and furnished by *The Foundry*, for $1.00 net..

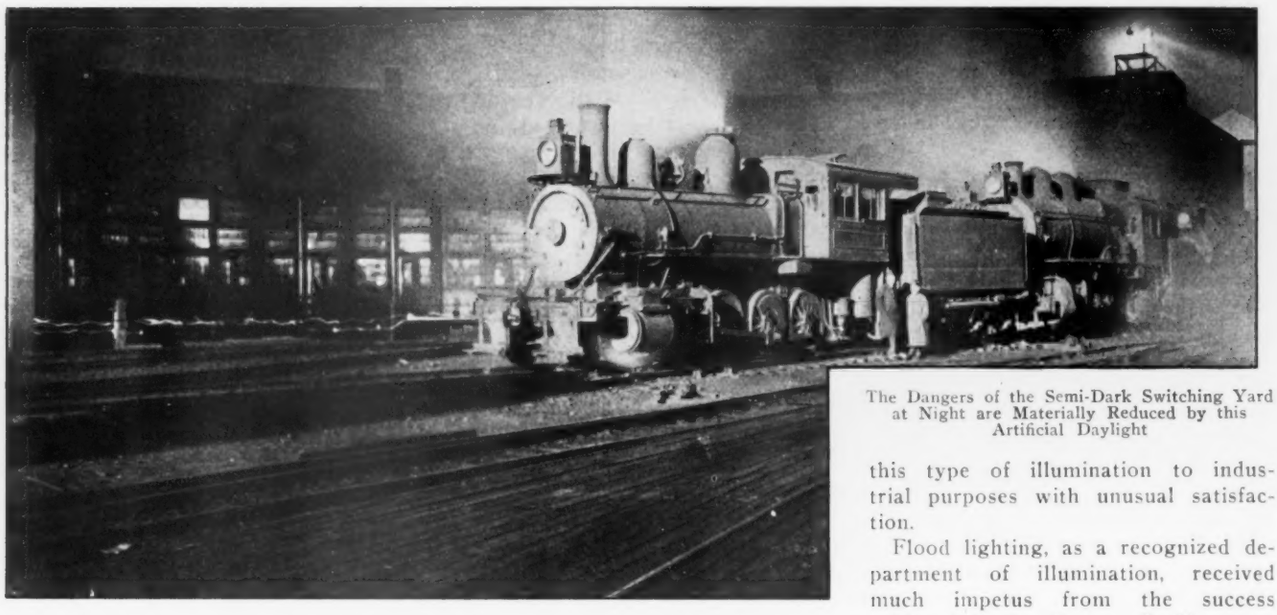
The most effective methods of employing labor is a problem whose solution has occupied a position of increasing importance in the attention of the industrial public in recent years. How to get a satisfactory position, a subject closely akin to the first one and with an equal need of exposition, unfortunately, has played the poor relation in respect to the notice given it. The book under consideration offers itself as a remedy for this omission.

Each man has capabilities which make some particular form of occupation more acceptable than others to him. In the words of the book, "An axiom of life is that a man will be most successful in that field of work which he loves best." *"Selling Your Services"* attempts to make clear to the reader how he can discover this special field for which his talents fit him, and, having discovered it, how he can locate and secure work of the type he desires. The first step is to get, or keep, as the case may be, some kind of work, whether it chances to be of the most congenial type or not. The idea being that an employer looks with more favor on the man with a job who wishes to better his position than on the man without a job who, therefore, has to make bothersome explanations about why he is in that condition. If opportunity for beneficial change exists in the company with which the person ambitious for advancement finds himself, he is advised to stay with that company, as a reputation for business "loyalty" is a great asset to a man. If no such chance does exist, then the means for locating a position which will prove satisfactory must be investigated and the proper persons must be communicated with. It is always considered in better taste not to seek employment from a competitor of your present employers unless your work is of a type which precludes your entering allied industries.

How to find the new position is next considered. If it is to be located by means of a "situation wanted" advertisement, very good advice concerning the form of the advertisement is given. If the applicant is answering a "help wanted" advertisement, equally valuable instructions are given concerning the important points connected with the letter of application. The matter of a personal interview with the prospective employer is discussed next.

The letter written and the visit made, the applicant is advised to keep himself in the mind of the man from whom he desires employment until he gets the position or hears that it is no longer available. The various follow-up methods are described and their methods discussed.

The annual convention of the sales and factory organizations of the Chicago Pneumatic Tool Co., Chicago, was held at the Great Northern hotel, that city, Jan. 11 to 13. The program included a trip to the company's plant at Chicago Heights, concluding with a banquet at the Great Northern hotel on Saturday, Jan. 13.



The Dangers of the Semi-Dark Switching Yard at Night are Materially Reduced by this Artificial Daylight

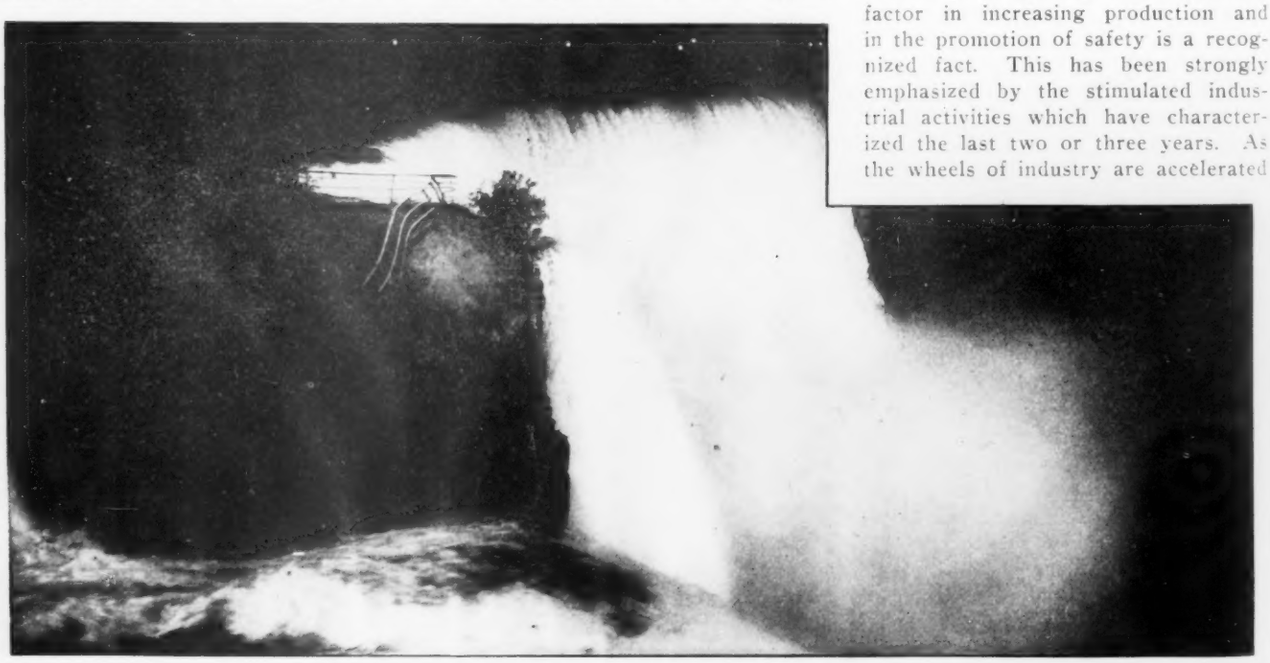
Use of Flood Lights in Industries

WHEN the flood-lighting units that illuminate the Statue of Liberty were first energized on Dec. 2, 1916, at a word from President Wilson, the successful culmination of three years' effort and development on the part of flood-lighting experts was realized. The beautiful effect of this illumination is certainly commensurate with the importance of the statue as America's most famous monument. While the lighting of Liberty attracted international notice because of the traditions and sentiments connected with it, this installation of flood-lighting units is, of course, but one of hundreds now in operation throughout the United States. The development of suitable lamps and reflectors for this effective type of illumination has led to its adoption for many purposes. The wonderful scenic effects of flood lighting on Niagara Falls, a reproduction of which is shown at the bottom of this page, make that installation worthy of particular mention. The use of light from powerful reflectors to bathe the exterior of buildings and for installations similar to those at the Falls and Bedloe's island, has brought the desirable features of flood lighting to the attention of engineers, who have applied this type of illumination to industrial purposes with unusual satisfaction.

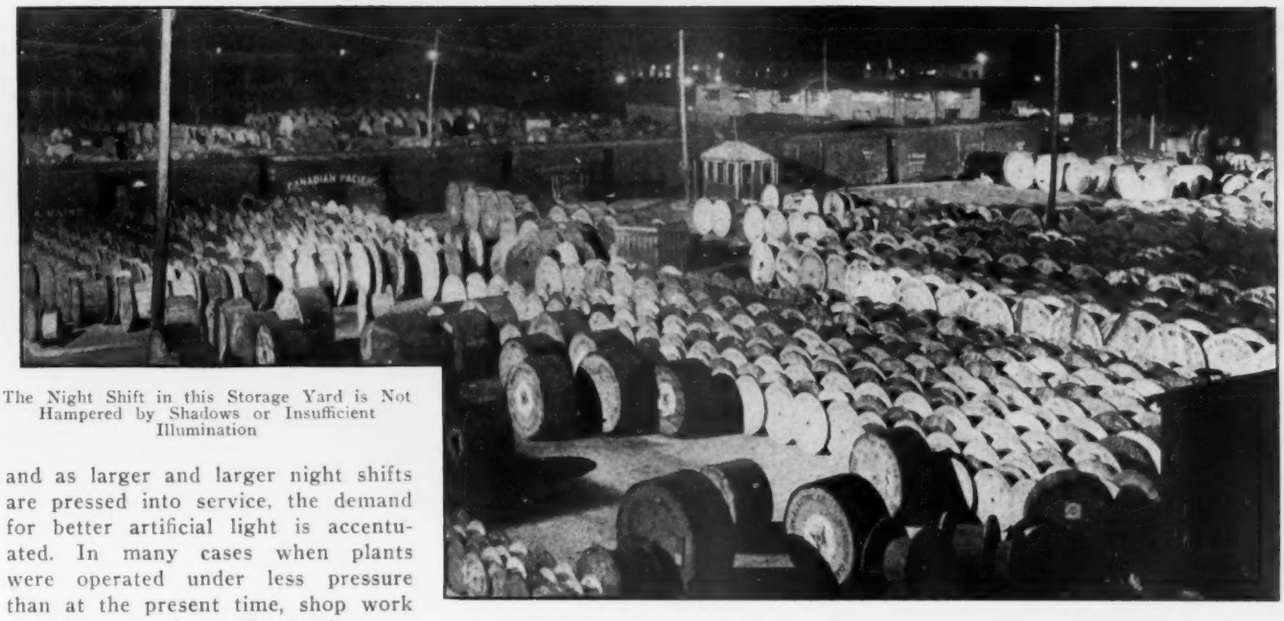
Flood lighting, as a recognized department of illumination, received much impetus from the success achieved at the Panama-Pacific exposition where the buildings, gardens, towers and patios were bathed in beautiful, vari-colored lights from hundreds of concealed projectors. More than 600 acres of the exposition grounds were at night actually made to resemble day. This is the effect, without the decorative frills, that is so desirable for large areas used for industrial purposes. The even, well balanced illumination produced by flood lighting makes its use particularly applicable to storage yards, switching terminals of railroads and to large, open interiors such as foundries.

Good Lighting Increases Production

That good lighting is an important factor in increasing production and in the promotion of safety is a recognized fact. This has been strongly emphasized by the stimulated industrial activities which have characterized the last two or three years. As the wheels of industry are accelerated



THE MAGNIFICENT SPLENDOR OF NIAGARA FALLS IS REVEALED IN ANOTHER PHASE OF ITS BEAUTY BY FLOOD LIGHTING



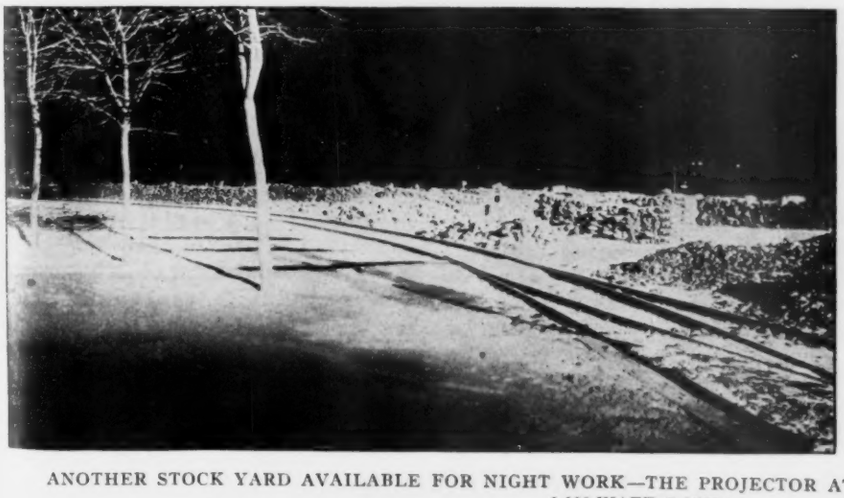
The Night Shift in this Storage Yard is Not Hampered by Shadows or Insufficient Illumination

and as larger and larger night shifts are pressed into service, the demand for better artificial light is accentuated. In many cases when plants were operated under less pressure than at the present time, shop work requiring only local illumination was carried on through the night with satisfaction. By increasing the operating forces working in the storage yards, the products of the night shift could be distributed during the daylight hours. Now, however, with the stress of production so high, all departments of many plants are necessarily operated for 24 hours a day. This condition, therefore, creates the necessity for satisfactory illumination in a number of places not heretofore supplied with artificial light.

Uniform Illumination Without Glare

The illustrations which accompany this article were made from unretouched photographs; they show practical installations of flood lighting equipment in switching yards, storage yards and similar places. Particular attention is called to the uniformity of the illumination, and the absence of strong shadows. It will be noticed that the light which is projected from the reflectors is distributed in a flood of light rather than in solid beam. Such distribution eliminates the disagreeable, and often dangerous, blinding effect which would be noticeable if the light were not diffused properly by the projector.

A type of flood-lighting projector which is used at Niagara Falls and which is used largely for industrial purposes is shown at the right of this page. This projector has been developed by the Western Electric Co., Chicago, and is equipped with a mirrored lens and a 1,000-watt incandescent lamp. The casing of the unit is either cast iron or steel, depending upon whether the lamp is to be used where it will be protected from rain and snow or whether it will be subjected to attacks of all kinds of weather. It is mounted on a hollow pipe standard, which is fastened to a large base of sufficient weight to give the lamp stability without bolting. A swivel joint is provided at the point where the projector is joined to the standard. This arrangement



ANOTHER STOCK YARD AVAILABLE FOR NIGHT WORK—THE PROJECTOR AT THE RIGHT IS EQUIPPED WITH A 1,000-WATT LAMP

allows the lamp to be turned conveniently in all directions. Thus, if the lamp is to be used in connection with construction work, it may be set in one place and turned to follow the course of construction as the work proceeds.

Flood lighting has assisted in solving the difficult problem of lighting foundries in a great many cases. At the time of pouring, the smoke rising from the molds tends to obscure the ordinary light sources. By placing flood lights at opposite corners of the foundry and directing their light horizontally across the molding floor above the heads of the workmen, the smoke from the molds is illuminated and in turn reflects the light to the floor below and provides a glareless, uniform light. Such illumination in foundries, especially when molten metal is being handled, tends to reduce the accident liability. The increased efficiency of the men and the attendant increases in production resulting from the use of proper illumination in industrial plants more than compensate for the original cost and small upkeep expense of the equipment.

The Seasoning of Castings

By Richard Moldenke

ONE of the little-known characteristics of cast iron, which nevertheless has an important bearing on results where accuracy in machining is essential, is the ability of this material to ease up internal strains when allowed to remain quiescent for a more or less extended period of time. It seems as if the molecules in such a casting, by virtue of their mobility, can adjust their relative positions to an extent sufficient to overcome some of the existing stresses.

The following instance will perhaps give a fair idea of the condition a casting may be in when just shaken out of the sand. A very large sheave-wheel, after shaking out, was taken outdoors to be cleaned and made ready for turning up. It was leaned against the side of the building, but before much could be done, an arm tore apart with a loud report. Investigation showed that the sun had been shining on the upper rim, thus adding a slight strain to those already existing within the arm and thus overbalancing the strength of the metal in tension. Had this sheave been kept under cover for a while, or at least until machined, the strains would have eased off sufficiently and allowed the sun to look upon it without disaster.

It will not be necessary to multiply examples. Every engineer knows the danger of water-hammer in pipe lines, particularly if the latter are of cast iron. Every mechanic knows, or should know, that it is not good to strike a fitting that is under steam pressure.

Shrinkage and Contraction

It will be necessary to write a few words about the internal strains in castings—the so-called casting strains we hear so much about. It is generally known that to get a casting reasonably true to the dimensions wanted requires a slightly larger pattern. The usual allowance for gray iron is ⅛ inch to the foot and ¼ inch to the foot for white iron. This reduction in length, breadth and thickness in a casting is erroneously called shrinkage. It should be called contraction, as for practical purposes it is simply the difference in dimensions of the casting red-hot and cold. In fact, it is really a volumnar contraction, and takes place after the metal has set.

The real shrinkage covers an entirely different situation. When a casting is poorly designed, it is impossible to feed the mold properly when pouring. The thinner sections set more quickly than the thick ones and may leave the latter without means of drawing in liquid metal to compensate for the reduction in volume in the act of setting. As the metal sets against the mold walls first, and gradually thickens from the surface inward, when the influx of fresh supplies is stopped there results a void in the center, or at least a spongy portion. This is shrinkage, and can be seen more particularly in white iron, by reason of its greater reduction in volume from liquid to solid form, apart from the final contraction from red heat to ordinary temperatures. Such shrinkage usually takes place at abrupt angles, in thick parts adjoining thin ones, in the rims of flywheels, hubs of pulleys, at the flangers of cylinders, etc.

It will be seen from the above that there are really two kinds of reduction in volume to be reckoned with: *First*, that due to the change from the liquid to the solid state; *second*, the reduction in volume after setting until ordinary temperatures have been reached. The first, often called interior shrinkage, is a rather serious occurrence. The specific gravity of molten iron is about 6.65; it does not vary widely from this figure whether the metal on setting is gray or white in fracture—all the carbon being combined when in the molten state. On setting, however, if gray iron results, the specific gravity will be over 6.8, and if white iron, up to 7.8. The formation of graphite in the structure accounts for the comparatively moderate increase in the case of gray iron. In average cast iron with 7.3 specific gravity, the increase in density is 0.65, or 9 per cent, which means a very big decrease in volume for equal weights of molten and solid metal. This situation accounts for the quantities of molten metal that have to be added to a mold after pouring it full in the first place, and in the case of small castings, particularly when of white iron, for the funnel-shaped sprue left in the pouring basin or gate.

Interior Strains Reduce Tensile Strength

Contrast this with the eventual reduction in volume after setting. Here we have a linear reduction of about 1 per cent in every direction, which is an infinitesimal amount when compared with the real metal shrinkage.

It stands to reason that if the metal in setting has the power to pull apart, whatever liquid material may remain after feeding has stopped, thus causing large, spongy parts in the interior of a casting; powerful strains which affect the strength injuriously must have occurred. This is apart from the reduction of strength in the material for the section itself. In other words, not only will the metal have a lower tensile strength because of the spongy nature of part of the section, but the interior strains counterbalance part of the tensile strength that is available.

This situation is intensified by the fact that the metal in setting does so far more quickly at the mold surface than in the interior—the cold sand walls drawing away the heat from the molten iron more quickly at the beginning of the setting process than later when this heat has to travel through a more or less thick shell of metal already set. The consequence is a higher percentage of combined carbon at the surface than in the interior of the casting. In chilling the surface, we have a white

A paper presented at the New York meeting of the American Institute of Mining Engineers, February, 1917. The author, Richard Moldenke, is consulting metallurgist, Watchung, N. J.

CUBIC FEET OF AIR AT 65 DEGREES FAHR. HANDLED PER MINUTE THROUGH AVERAGE DUST-COLLECTING HOODS

From Information Furnished by B. F. Sturtevant Co., Hyde Park, Mass.

(Based on Coefficient of Orifice of 0.71 with 10 Per Cent Added for Leakage.)

Diameter of connection pipe, inches	Maintained Suction—Inches Water Gauge— 1	1½	2	2½	3	4	5
1½	38	47	54	61	67	76	86
2	68	84	97	108	118	136	153
2½	107	131	161	168	185	214	238
3	153	188	217	243	266	306	343
3½	209	256	296	330	362	418	466
4	273	334	386	431	473	546	609
4½	345	423	488	546	598	690	775
5	427	523	605	676	741	854	955
6	614	751	867	970	1,062	1,228	1,373
7	835	1,023	1,181	1,322	1,448	1,670	1,870
8	1,092	1,337	1,546	1,727	1,892	2,184	2,440
9	1,381	1,694	1,953	2,184	2,387	2,762	3,091
10	1,705	2,090	2,409	2,695	2,959	3,410	3,806

CONNECTION PIPES FOR GRINDING AND POLISHING WHEELS

From Information Furnished by B. F. Sturtevant Co., Hyde Park, Mass.

The sizes of connections suggested for grinding and polishing wheels are those given in the tables by the department of labor of New York, with the exception of those for polishing wheels 21 inches and over in diameter.

MINIMUM SIZES OF BRANCH PIPES FOR EMERY OR OTHER GRINDING WHEELS

Diameter of wheels	Maximum grinding surface square inches	Minimum diameter of branch pipe in inches
6 inches or less, not over 1 inch thick	19	3
7 inches to 9 inches, inclusive, not over 1½ inches thick	43	3½
10 inches to 16 inches, inclusive, not over 2 inches thick	101	4
17 inches to 19 inches, inclusive, not over 3 inches thick	180	4½
20 inches to 24 inches, inclusive, not over 4 inches thick	302	5
25 inches to 30 inches, inclusive, not over 5 inches thick	472	6

MINIMUM BRANCH PIPES FOR BUFFING, POLISHING OR RAG WHEELS

Diameter of wheels	Maximum grinding surface square inches	Minimum diameter of branch pipe in inches
6 inches or less, not over 1 inch thick	19	3½
7 inches to 12 inches, inclusive, not over 1½ inches thick	57	4
13 inches to 16 inches, inclusive, not over 2 inches thick	101	4½
17 inches to 20 inches, inclusive, not over 3 inches thick	189	5
21 inches to 27 inches, inclusive, not over 4 inches thick	338	6
27 inches to 33 inches, inclusive, not over 5 inches thick	518	7

Where the branches are extremely long, the friction loss in the system may be decreased by making pipes ½ inch greater in diameter than the sizes given in above tables.

SIZES OF CONNECTIONS FOR WOOD-WORKING MACHINERY

From Information Furnished by B. F. Sturtevant Co., Hyde Park, Mass.

Type of machines	No. of connections	Diameter of pipe, inches
Swing saws: Small size on dry kiln lumber, large on wet	1	3½ to 6
Rip saws: Dry kiln material	1	4
Not dry kiln material	1	4½
Self-feed saws	1	5
Table saws:	1	4
For box factory work	1	4½
Mitre saws	1	4
Variety saws	1	4
Variety saws with dado head	1	5
Double saws	2	5
Gang saw (Dependent on size and number of saws)	.	6 to 9
Band saws:		
Blade under 2 inches wide	1	4
Blade 2 inches to 3 inches	1	5
Blade 3 inches to 4 inches	1	6
Blade 4 inches to 6 inches	1	7
Blade 6 inches to 8 inches	1	8
Jig saws	1	4
Tenoning: Single head	1	5
Double head	2	7
Double end double head	4	10
Variety moulder or shaper: Single head	1	4½
Double head	2	6
Double head, heavy work	2	8
Sanders:		
Belt—Less than 6 inches wide	1	4½
Belt—6 to 8 and 10 inches wide	1	5
Belt—12 and 14 inches	1	6
Drum—24 inches long	1	4
Drum—30 inches long	1	5
Drum—36 inches long	1	6
Drum—48 inches long	1	8
Drum—Over 48 inches	1	10
Disc—24 inches diameter	1	5
Disc—26 inches to 36 inches	1	6
Disc—36 inches to 48 inches	1	7
Arm sander	1	4
Planers, matchers, moulders, stickers, jointers, etc. (all top and bottom heads).		
Knives 6 inches to 8 inches	*	5
Knives 9 inches to 14 inches	*	6
Knives 15 inches to 20 inches	*	7
Knives 22 inches to 26 inches	*	8
Knives 28 inches to 36 inches	*	9
Side knives under 15 inches	*	4½
16–20 inches	*	5
21–24 inches	*	6

*One hood for each cutter.

The above table gives the sizes of connections commonly used with wood-working machines, but it is not intended to restrict the pipe to these diameters, as the size varies with the quantity of shavings, the kind of lumber, its condition, whether wet or dry, and the variation in speed of the cutter heads. Modern high-speed machines require larger connections than older types, even though the cutters be of the same size. Experience will dictate just what increase is necessary.

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE FOUNDRY DATA SHEET, MARCH, 1917

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

iron surface and a gray iron interior. The relative change in the specific gravities of the same molten iron turned into two extreme forms of iron as cast will indicate what strains there must be within the casting due to the differences in volume which the two metals want to occupy when set, but cannot properly occupy on account of the quickness of the setting action.

Finally come the strains due to the contraction in the set material until ordinary temperatures have been reached. This has been stated as ⅛ inch to the foot in gray iron and ¼ inch to the foot in white iron. In large castings this is very serious. Suppose, in the case of a big flywheel, the rim sets fast enough to hold the much cooler arm as in one set of jaws of a testing machine, the hub, held by the arms on the other side of the wheel, being the other set of jaws. Surely the arm in wanting to reduce in length ⅛ inch to the foot must be under a terrific strain if not allowed to do so. In the case of white iron the situation is much worse. Such castings as hand-brake wheels (subsequently annealed for malleable castings) snap apart when allowed to cool in the sand in the ordinary way. Work of this kind must be shaken out as quickly as set, taken to special ovens and allowed to cool down very gradually.

Sufficient has been said to make the case of cast iron look very weak. Fortunately, there are two phenomena which help to overcome some of the injurious strains set up. The first is the fact that cast iron in the act of setting (between liquid and solid) can be stretched. The second is the seasoning or easing up of the remaining strains after the final contraction through the mobility of the molecules. It is the stretching of gray iron during the setting that saves the flywheel arm from rupture before the new strains due to final contraction are introduced. It is the inability of white iron to stretch very much, which causes so many cracked castings in the malleable process which would not be seriously affected by the final contraction.

Test Guarantees Unfair

This discussion of the actual situation in making castings has another bearing. Purchasers of castings may wonder why foundrymen who really know something about their basic material are so uncompromisingly opposed to test coupons on their product. The man who is at least somewhat familiar with cast iron should realize that it is unfair to the maker of the casting to judge its value by a test piece subject to a variety of strains introduced as the result of position, manner of attachment, method of pouring of the metal, etc. It is further unfair to the purchaser to judge by coupons, as there are many ways of artificially strengthening such test pieces. There is only one way of testing a casting properly, and that is to break it. Obviously this will not do, and hence for repetition work a given percentage of castings can be thus tested. For all other cases the only method of obtaining reasonable assurance on the subject is to make standard test bars, entirely apart from the castings, but of the same iron. These test bars should be made under conditions giving the iron the best possible chance to show just what it is, neither artificially strengthened, nor filled with strains and thus deliberately weakened.

Every mechanic knows that in planing up a slab of cast iron on both sides to get a true job, it is necessary to take a light cut, reverse, and take a cut on the other side, then reverse again for the finishing cut, finally reversing for the last cut. If this is not done, there will be warped surfaces to deal with on account of the internal strains. Again, it is well known that a true piston is rather difficult to produce. Even after grinding to a finish, it is apt to get out of true. It is not so generally known, however, that if such a cast iron plate or piston is allowed to remain in storage for a long period, the results will be much more satisfactory. The castings have seasoned. Where establishments are familiar with future production demands, orders for castings are placed far ahead of requirements. Since, however, on getting to the bottom of a big pile the difficulty of tracing defective work becomes correspondingly harder, only shops having their own foundries are likely to do much storing.

The present demand for very high-class machined castings, as evinced by automobile cylinders, pistons, engine and compressor cylinders, etc., should bring this question of seasoning out very prominently. Inquiry by the writer has shown but little knowledge on the subject in the trade generally, though first-class foundrymen were very much alive to the matter. In general, the difficulty seems to be the inability of storing up ahead, or, if this is done, of discovering defective product when least expected.

We are indebted to the well-known metallurgist, A. E. Outerbridge Jr., for what seems to be the best indirect explanation of seasoning. In his famous experiments on tumbling castings to increase their strength, he found that by the action of light blows, often repeated, the internal strains were relieved to such an extent that the real value of the metal came into play. The mobility of the molecules was aided by artificial means. Incidentally, however, the tests establish the mobility of the molecules in cast iron very satisfactorily. Replace half-an-hour's tumbling by six months' quiescence and the molecules will have done their work with somewhat the same results.

In view of the possible depression scheduled for this country on the close of hostilities in Europe, would it not be well to ease up operations slowly instead of shutting down tight? This would help the industrial situation adjust itself more safely and at the same time permit supplies of castings to accumulate, which will be all the better for having seasoned.

SLOW MELTING AND BRIDGING

By W. J. Keep

Question:—Slow melting and bridging is the difficulty we are experiencing with our cupola which has a 60-inch shell and is equipped with special tuyeres. It is absolutely essential that we have hot iron, since we do a large amount of cylinder work and the iron must be carried a considerable distance before pouring. However, after seven or eight tons have been melted, the iron begins to get dull. The tuyeres have given excellent satisfaction on small heats, but on large heats bridging occurs. We have boshed the cupola to accommodate this style of tuyeres. Up to a few months ago our heats averaged 14,000 to 16,000 pounds, when no trouble was experienced, but the melt is growing from day to day and our difficulties are increasing in proportion. Our coke bed extends 24 inches above the upper tuyeres and the bed charge of iron consists of 2,500 pounds and the succeeding charges are 1,600 pounds of iron to 200 pounds of coke. Several days ago we made a heat of 22,500 pounds. The blast was put on at 3:15 p. m. and the bottom was dropped at 5:35 p. m. The heat required two hours and 20 minutes and we would like to cut down this time if possible. I would like to know whether I can use a straight lining. While the cupola has a shell diameter of 60 inches, 4-inch brick is used for lining, making the cupola diameter 52 inches. Also, would you suggest a single row of tuyeres with nearly continuous openings about 4 inches deep, 12 inches wide next to the shell and flared to 18 inches at the lining? At present, the cupola is provided with 11 lower tuyeres, 7 x 3½ inches and six upper tuyeres, 3 x 3¼ inches. The blast is

furnished by a fan, being delivered through a 15-inch blast pipe. The blast gage records 11 ounces at the beginning of the heat and 12 ounces at the middle of the heat. We have tried slagging, having used about 20 pounds of limestone on each charge, but the slag was not fluid enough to run freely. I was afraid to use more, fearing the formation of excessive slag. At present we are using only a small amount of limestone, sufficient to make the slag brittle. All of our sprues are milled, since we believe it advisable to keep all slag-forming materials out of the furnace. I personally inspected the cupola in the morning and a mass of coke and slag covered the lining between the lower and upper tuyeres. Within two or three weeks we expect to increase our heats to 28,000 pounds and, therefore, it is essential that we eliminate our difficulties as soon as possible.

Answer:—It would be advisable to refer this problem to the maker of this peculiar type of lining. We are using cupolas of the same size and practically the same lining, but with only one row of tuyeres. Some time ago our melting ratio was published in these columns, which represented the consumption of one pound of coke to 9½ pounds of iron for a 28-ton heat melted at the rate of 12 tons per hour, but we were requested to withdraw the statement by the party who recommends this special lining, since he did not believe that this could be done. The same thing can be accomplished with a straight lining, but similar results can be obtained with the boshed lining which you have. You certainly can get along with less bed coke with a boshed cupola. If your lower tuyeres are continuous and 3½ inches high, you will probably get enough air. The thin iron supports from the tuyeres can be set back slightly. It might be advisable to close the upper tuyeres with a thin piece of brick. When you begin to charge iron, see to it that the coke extends 18 inches above the top of the lower tuyeres if the upper tuyeres are cut out. Be sure that you light your fire two hours before the iron comes down, so that the cupola is hot enough to melt iron when charging begins. Be careful to avoid charging sweepings either from the foundry or the charging floor.

Your cupola should be slagged after the first three charges, or before if the slag will run. Be sure that you are using good limestone and not dolomite. Use enough of this flux to produce a fluid slag, 20 pounds not being sufficient, since it will probably take from 40 to 60 pounds. You should not allow the slag to remain in the cupola. Your blast pipe is small and you may have some sharp bends in it. The best way is to learn to use what you have, before you make extensive changes.

Making Large Pure Aluminum Castings

Foundrymen who have attempted to cast pure aluminum realize the difficulties involved in this work. Recently the Sheeler-Hemsher Co., Philadelphia, received an order for pure aluminum castings of large size, which were made without cracks or draws and which developed no unusual shrinkage spots. A number of these castings are shown in Fig. 1 and an enlarged view of one of these cylinders is illustrated in Fig. 2. This cylinder weighs 350 pounds, has an outside diameter of 42½ inches with 2-inch flanges inside and outside, consisting of ¾-inch. metal. The remarkable feature of this work is the fact that a dry sand core was used and it was believed that possibly the cylinders would crack in cooling. However, the first attempt proved successful and all of the castings passed a rigorous inspection.

Annual Meeting of Testing Society

The 20th annual meeting of the American Society for Testing Materials will be held at Atlantic City June 26-30, with headquarters at the Hotel Traymore. That this watering place is favored by the large majority of the members of this organization is indicated by the results of a vote taken several months ago to select the time and place for the next annual gathering. Out of 453 ballots cast, Atlantic City was favored by 256, Chicago 56, New York 42, Washington 18, Pittsburgh 17 and scattering 64. Two hundred and seventy-six members favored June, of whom 175 named the last week of that month. Notwithstanding the increase of 50 per cent in dues, which became effective Jan. 1, 1916, the growth in membership has been well maintained, the net increase for last year having been 171, as compared with 208 the previous year. The present total membership is 2,132, which represents a net increase of 62, as compared with the figures reported at the last annual meeting.

The Federal Foundry Supply Co., Cleveland, received a contract from the United States Navy Yard to supply all of the graphite used by its foundries in 1917.

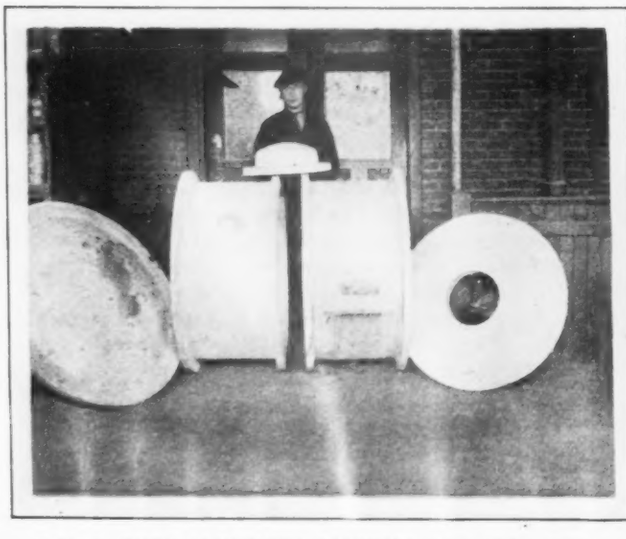


FIG. 1—PURE ALUMINUM CASTINGS OF LARGE SIZE MADE BY THE SHEELER-HEMSHER CO., PHILADELPHIA

FIG. 2—ANOTHER VIEW OF ONE OF THE CYLINDER CASTINGS MADE SUCCESSFULLY BY THE USE OF A DRY SAND CORE

Molding Wheels and Sheaves With Steel Spokes

How to Properly Arrange the Mold and Place the Gates so That the Contraction of Various Parts of the Casting is Equalized

By R H Palmer

MANUFACTURING steel spoke wheels and sheaves is attended with an unusual amount of difficulty, and unless the foundryman who attempts to make castings of this kind has had considerable experience in this line of work, his efforts undoubtedly will be unsuccessful. To insure satisfactory results, certain fundamental principles in the preparation of the mold and the pouring of the metal must be followed. The operations to be outlined in this article constitute the practice followed in a plant where wheels and sheaves have been manufactured successfully for many years.

Fig. 1 shows a common type of wheel varying in diameter from 6 to 10 feet. The rims weigh from 2,000 to 8,000 pounds and the hubs range in weight from 600 to over 2,000 pounds. The steel spokes are about 1¾ inches in diameter.

When molding a wheel of this type, it is much more convenient to use cores to form the hub and the rim than to make the mold in a flask. The first operation involves the forming of a bed of green sand which is leveled as shown in Fig. 2. The bottom core, *A*, for the hub, and the bottom cores, *BB*, for the rim then are placed in position. The cores for the rim are made in sections and contain half circle indentures for the steel spokes, the same as the bottom hub core. The rim cores and the outer ends of the spokes are set up to the sweep, as shown in Fig. 3, to insure a perfect circle. After the lower spokes are set in place, the hub cores, *C* and *D*, are inserted, after which the upper tier of spokes is placed in position. The upper cores, *EE*, which are identical with *BB*, and the upper hub core, which is similar to *A*, are then added to the mold and securely clamped to the lower cores.

Fig. 5 shows the completed mold; *B* indicates the lower rim cores which form the inside of the rim. It will be noted that the outer edge of the rim is formed by green sand placed between the wooden segment *F* and the curbing, *G*. Seacoal facing is used between *F* and *G* to the height of the cores. Flat cores, in the form of segments, are placed on the mold to cover the rim, and the joints between these segments are covered with paper over which loose sand is thrown. The mold is weighted with pig iron to hold the cores in place.

The arrangement of the gating and heading of the mold is illustrated in Fig. 5. A large pouring basin is provided for the metal for the rim and a riser at the other side of the wheel furnishes a means of feeding the rim which is poured one day, and the hub the following day.

Foundrymen who have been accustomed to making light castings are liable to question the practice of feeding the rim. Experience has shown that rims of this kind, having a large cross-section, will sink down in the center, show signs of sponginess and will contain holes in various places unless provision is made for supplying hot metal to the inner portion of the casting as it cools. To supply the molten iron to the casting and to keep up its volume while passing from the molten to the solid state, it is necessary to provide a large riser. This riser, with the aid of a feeding rod which keeps open the path from the riser to the fluid metal in the casting, enables the foundryman to keep hot iron flowing into the casting, thereby preventing a loss in the volume of the section due to

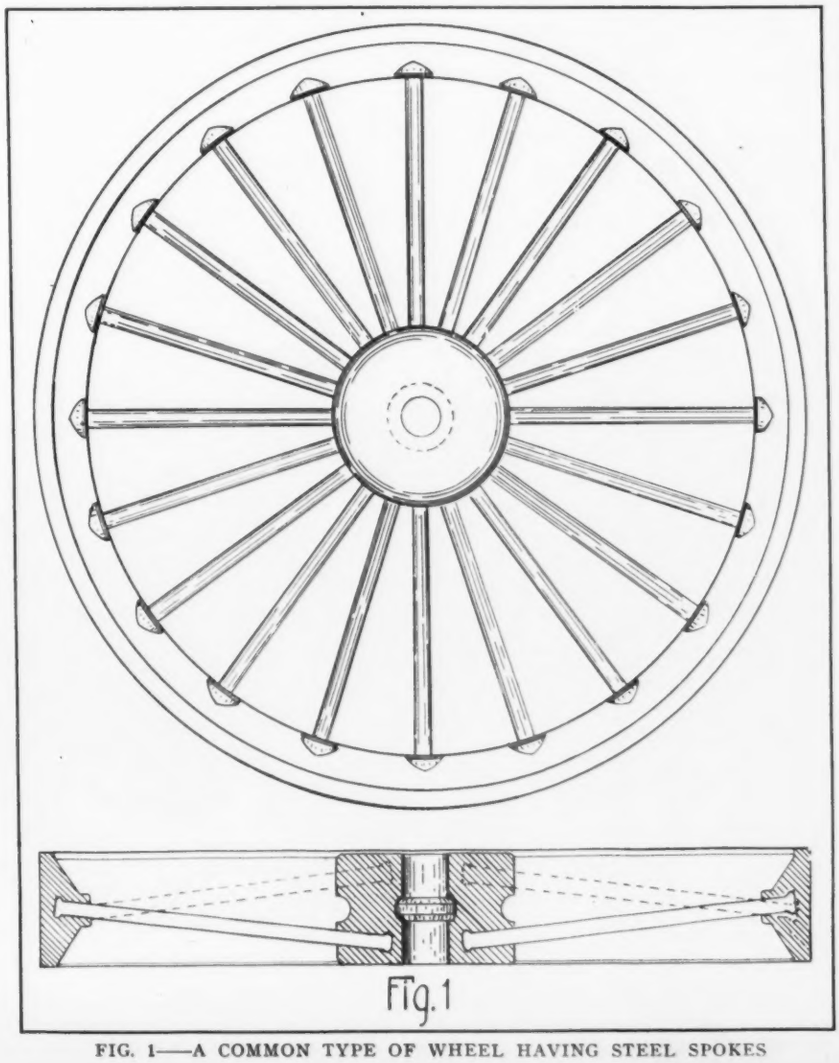
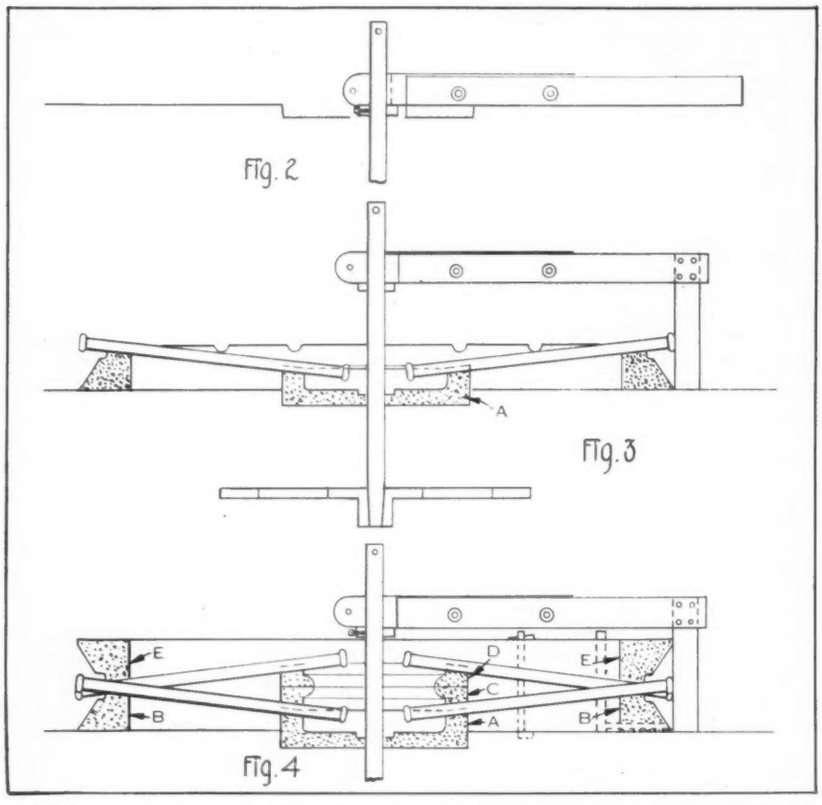


FIG. 1——A COMMON TYPE OF WHEEL HAVING STEEL SPOKES



FIGS. 2, 3 AND 4—SUCCESSIVE STEPS IN BUILDING-UP A MOLD FOR A WHEEL OF THE TYPE SHOWN IN FIG. 1

contraction. It has been found that a coating of silicate of soda, commonly known as liquid glass, has a beneficial effect upon the ability of the metal to firmly adhere to the steel spokes. As an indication of this, an interesting experiment may be cited. A band of cast iron, 4 inches thick and about 8 inches in diameter, was cast around a 1⅞-inch steel shaft. The shaft had been thoroughly cleaned and the metal was poured at white heat. It required a pressure of five tons on a hydraulic press to move the cast iron on the shaft. A second piece of the same shaft was cleaned and coated with silicate of soda, and a casting of the same size as in the first trial, was cast around the shaft. When placed on the press, a pressure of 35 tons was required to slip the casting on the shaft.

The analysis of the iron used in making the rim of the wheel of the type mentioned, follows: Graphitic carbon, 2.416 per cent; combined carbon, 0.780 per cent; silicon, 1.760 per cent; sulphur, 0.096 per cent; phosphorus, 0.578 per cent, and manganese, 0.52 per cent.

Designs of Rim Vary

The mold of a wheel similar in many respects to that shown in Fig. 1, but with a rim of different design is illustrated in Figs. 6, 7, 8 and 9. Wheels of this type range in diameter from 6 to 10 feet and have steel spokes 1 inch in diameter. The rims vary in weight from 700 to 3,600 pounds and the hubs from 400 to 1,800 pounds.

In preparing the mold for a wheel of this kind, the bed of green sand is leveled an indicated in Fig. 6, and the hub core, *A*, and the runner or gate cores, *BB*, are placed in position. Sand is then rammed level to the top of the gate cores in the space between the cores. This forms the bed on which are placed the lower halves of the core forming the inside of the rim. This sand bed also forms the inside edge of the mold below the rim cores. The center and top hub cores, and the steel spokes are assembled in the mold in the manner previously described. A segment similar to *F*, Fig. .5, then is placed against the inside of the rim and sand is placed on top of the top halves of the rim cores and between this pattern segment and the outer curbing of the mold, as indicated in Fig. 8.

Mold is Open at Top

The arrangement of the mold and the method of pouring differs from that previously outlined, the top of the rim being left open, eliminating the necessity for providing risers. As the metal is poured into the large pouring basin and

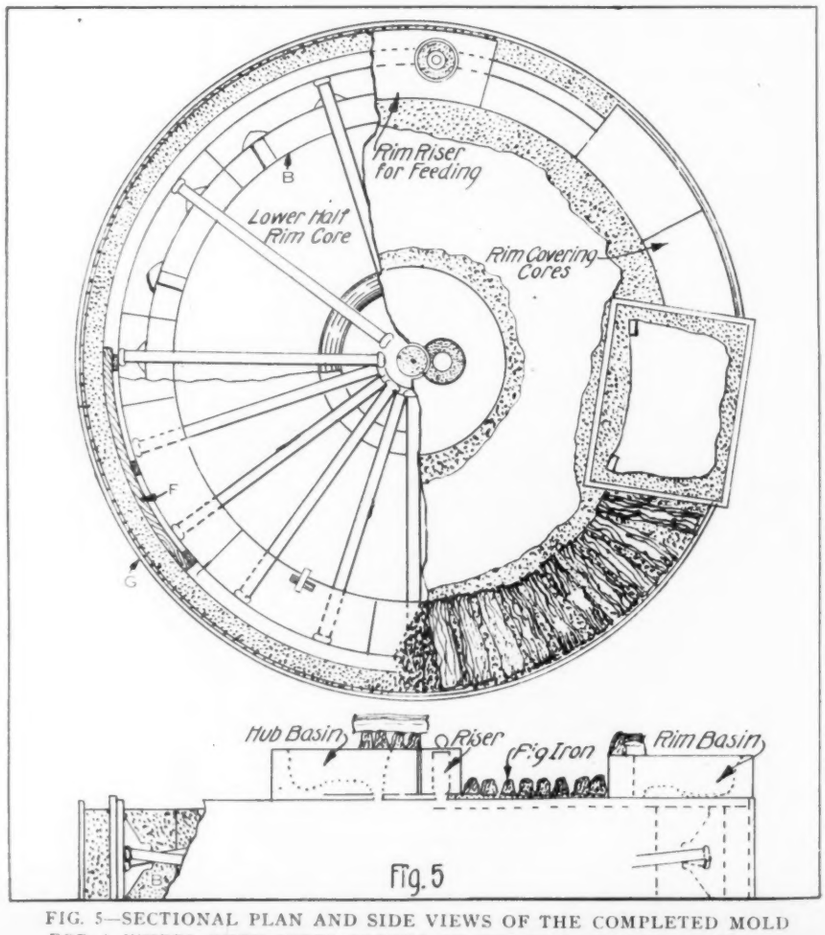


FIG. 5—SECTIONAL PLAN AND SIDE VIEWS OF THE COMPLETED MOLD FOR A WHEEL WITH STEEL SPOKES OF THE TYPE SHOWN IN FIG. 1

is fed to the mold through the gate leading to the bottom of the rim, men are stationed around the mold to guide the dirt and slag in the rising metal, by means of rods, to the top of the rim. Since the mold has been extended to a height to allow for this top edge of dirty metal, sufficient stock is provided to permit of machining off this undesirable metal.

Method of Gating Important

In this mold, the method of gating has a great influence upon the behavior of the metal while cooling, and consequently affects the shape of the casting. Fig. 8 indicates the gating arrangement that was employed for many years in making these wheels. The metal was poured into the large basin from which it flowed through the gates to the bottom of the mold where it entered the rim. The metal flowed around the rim until the two streams of metal met at the lower part of the rim at the side opposite the pouring basin. Naturally, at this point, the metal in the mold was more sluggish than that near the gate on the other side of the wheel, and this difference in temperature was made more pronounced by the chilling effect of the steel spokes upon the molten iron. The metal, at the side farthest from the gate, cooled much more rapidly than that below the pouring basin, and as a result the iron was harder at that point. Moreover, on the morning following the day on which the metal was poured, it was invariably discovered that the rim on the side opposite the gate had crept closer to the center of the wheel, as indicated by the dotted lines at *X*, Fig. 7. The gate, firmly held by the surrounding sand, served to prevent the pouring side of the rim to contract toward the center, thus accounting for the eccentric form of the wheel.

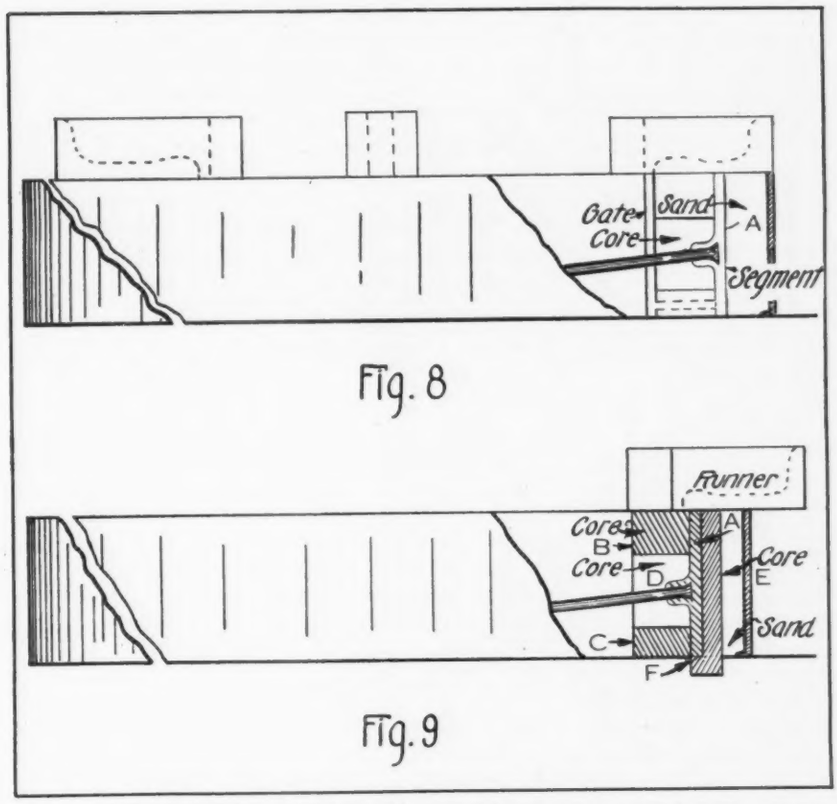


FIG. 8—A POOR METHOD OF GATING THE RIM. THE SPRUES PREVENT AN EVEN DISTRIBUTION OF THE SHRINKAGE STRESSES. FIG. 9—SATISFACTORY METHOD OF BUILDING-UP RIM MOLD

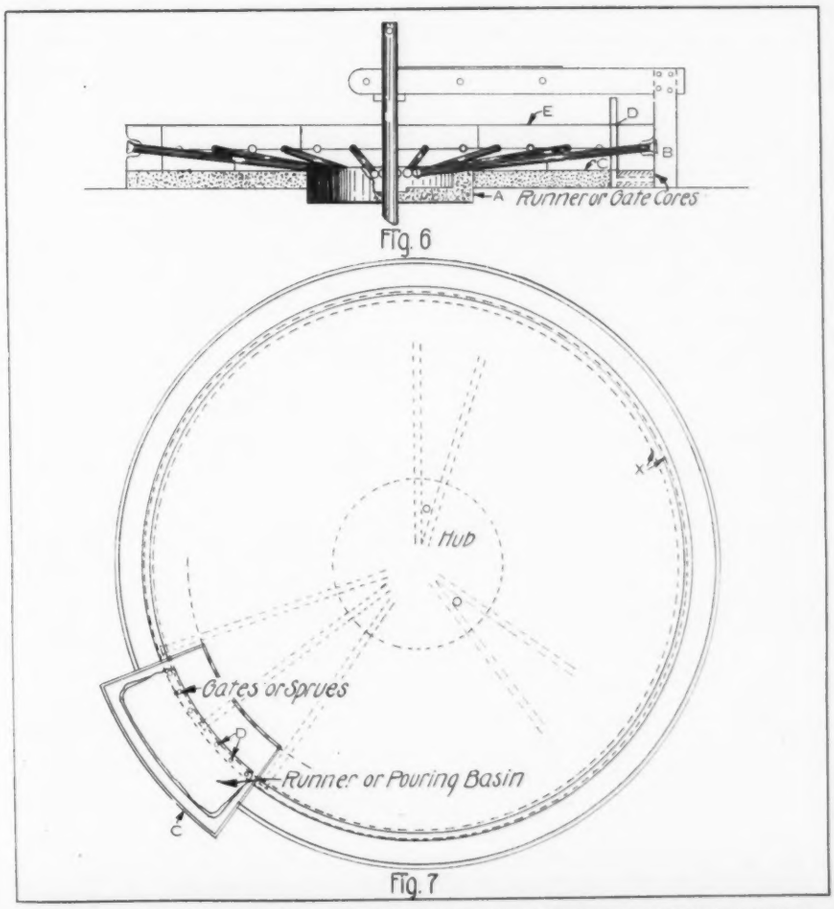


FIG. 6—DETAILS OF MOLD FOR SECOND TYPE OF STEEL SPOKE WHEEL
FIG. 7—PLAN OF MOLD. DOTTED CIRCLES SHOW ECCENTRIC RIM RESULTING FROM IMPROPER METHOD OF GATING

How to Equalize Contraction

The second, and preferable method of gating this casting, involves the use of cores for forming every part of the rim. The two cores which form the inside of the center of the rim are the same as those used in the other pouring arrangement, but instead of sand supplementing these cores, additional cores, as shown in Fig. 9, are employed. The outer and bottom faces of the rim are formed by a core with a lip on the bottom, extending underneath the casting to the core which forms the lower inside face of the rim. The pouring gate, in this instance, distributes the metal to the mold through a number of gates leading directly into the rim. These gates are spaced between the ends of the steel spokes, as shown in Fig. 7. When pouring, sheets of perforated tin are placed over the hole and the pour-

ing basin is filled as rapidly as possible. The metal is held back by the tin long enough to allow the dirt to rise to the top of the mold, and thus clean metal drains directly into the mold.

The hub should be poured on the side opposite that from which the rim was poured. A good mixture for the rims of wheels, similar to the one described, follows. Graphitic carbon, 2.536 per cent; combined carbon, 0.820 per cent; silicon, 1.680 per cent; sulphur, 0.086 per cent; phosphorus, 0.540 per cent, and manganese, 0.520 per cent.

Figs. 10 and 11 show the mold of a common type of sheave wheel having steel spokes, 1 inch in diameter. It will be noted that the hub is formed by cores in the manner employed in molding the wheels previously mentioned. The cores for the rim are in halves which form the center of the inside face of the rim, a core which forms the outer face of the rim and top and bottom cores which lie above and below the others. The metal is poured into the mold through gates in the top, or cover cores, or through gates leading into the center portion of the rim at its inside face. The former method is preferred, but in either case the metal should be poured simultaneously into three or four gates, evenly spaced on the rim. A riser should be provided to feed the hub.

In casting the two types of wheels and sheaves, many foundrymen experience trouble due to the breaking of the spokes. In the case of 7 and 8-foot wheels having light rims similar to that of the wheel in Fig. 6, the breaks usually occur near the hub. Investigation of this difficulty shows that if the hub is poured on the same side as the rim, and if hot metal is poured on or near the steel spokes, that the strength of the spoke is impaired. With hot iron dropping into the hub alongside of the spokes which previously have been subjected to the high temperature of the molten iron in the rim, and with the bottom gate retarding the shrinkage, the stress upon each of the few spokes near the pouring gate is in excess of that on any of the other spokes; consequently, one or more of them will not be strong enough to withstand the tension of contraction caused by the cooling of the hub.

To insure success in casting metal around the spokes, one or more gates, large enough to allow the hub to fill quickly, should be provided. If these precautions are taken, the spokes will not be burned, but will retain their original strength. Moreover, a steel that is too high in carbon should not be used, and under no circumstances should the hub be poured before the rim has had ample time to set. Sand should be rammed against the inner cores of the rim and against the outer cores of the hub, but the center section of each spoke should be left exposed as much as possible.

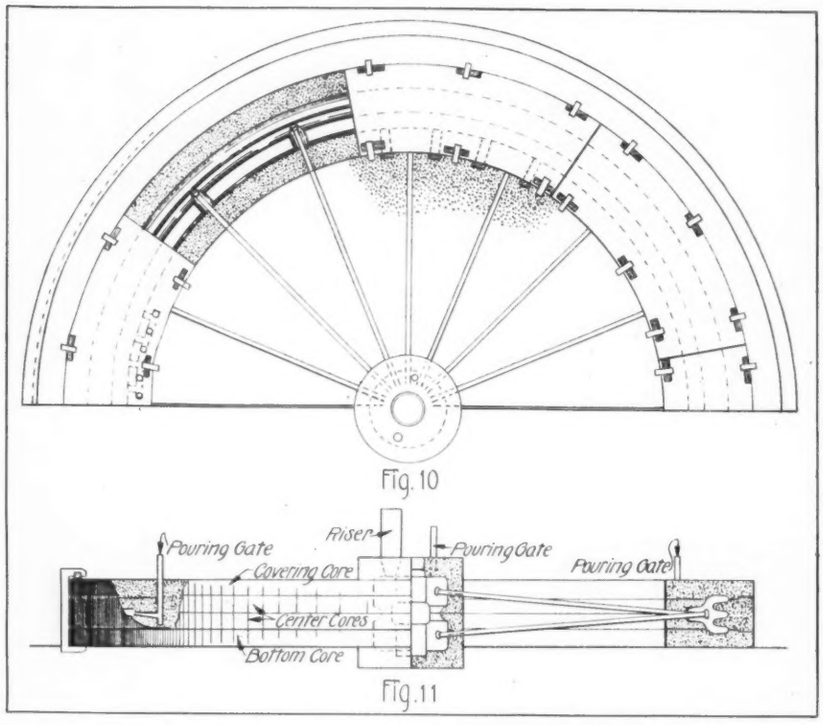


FIG. 10—PLAN OF MOLD FOR STEEL SPOKE SHEAVE WHEEL
FIG. 11—SECTIONAL VIEW OF MOLD SHOWING DETAILS OF HUB AND RIM CORES

Figuring the Cost of the Cupola Heat

By W. J. Keep

Question:—Kindly tell us the exact cost of iron as it is tapped from the cupola. Our recent heat, as shown by our daily report, totaled 7,100 pounds, which consisted of 1,200 pounds of coke at $10.80 per ton; 2,100 pounds of pig iron at $26.50 per ton; 700 tons of pig iron at $19.50 per ton; pig bed returned to the cupola, 750 pounds; gates charged, 1,200 pounds; machinery scrap, 900 pounds, at $12 per ton; stove plate, 950 pounds at $9 per ton; 500 pounds of shot, and 60 pounds of limestone, at $1.25 per ton. The cost of cupola labor was $8.25 for the cast.

Answer:—With cupola labor $8.25 for the cast with 1,200 pounds of coke at $10.80 per ton, the cost of the coke for the heat was $6.48 and the labor and coke for the charge of 7,100 pounds represented a cost of 0.21 cent per pound for the 7,100 pounds. The 2,100 pounds of pig iron cost $27.33; 700 pounds of pig iron, $6.72; 900 pounds of machinery scrap, $5.40; 950 pounds of stove plate, $4.28, to which must be added the cost of the 750 pounds of remelt pig bed, 1,200 pounds of gates and 500 pounds of shot, representing a total of 2,450 pounds to be charged at the cost of the mixture, representing an expense of $23.32. Against 2,450 pounds must be charged 0.21 cent per pound for labor and coke from the previous day, amounting to $5.14. The 60 pounds of limestone at $1.25 per ton represent a cost of 4 cents, making a total of $87.46 for the 7,100 pounds of iron melted, or a cost per pound of 0.0123 which is equal to $24.64 per ton. Taking into consideration incidentals, such as lining of cupola, etc., the cost would be approximately $25 per ton.

Belt Slings for Cores

A New England foundryman uses old leather belts as slings for carrying heavy cores around the shop. These slings, which are about 5 feet long, are suspended from the crane hook in the same manner as ordinary chain slings. They are particularly suited for handling round or barrel-shaped cores 6 inches or more in diameter. The leather grips the core firmly and at the same time does not injure or scratch it in any way. Slings of this type cost practically nothing, since old belts that are useless for power transmission may be employed. Such belts are even preferred to new ones on account of their superior flexibility. Belts from 3 to 4 inches wide are considered most satisfactory.

Protective Coatings: Lacquers---I

By E P Later

AMONG the many materials used in the art of finishing and protecting metals, few are of greater importance or deserve more careful study than the lacquers and japans or enamels. It is one thing to produce, by plating or coloring processes, a finish which is beautiful and pleasing to the eye, but it is an entirely different problem to preserve its beauty for any considerable period of time, since almost without exception such finishes are comparatively unstable in the air and soon fade or tarnish unless they are protected by some kind of a coating which will exclude air and moisture.

The substance which is commonly known as lacquer is widely used for this purpose, in the form of a clear, slightly yellowish liquid that, beyond giving a rather high lustre to the surface, does not add to or detract very much from the appearance of the finish. By the addition of dyes, however, lacquers can be made to protect not only the finish from tarnishing, but will enhance its beauty greatly and thus serve a double purpose.

Knowledge of Composition and Application

To obtain the best results, however, in this as well as in any other line, requires at least some knowledge of the composition and proper methods of application of these materials. Many a plater has wondered why his special finishes did not hold up and has sought various explanations for this, without suspecting that a poor lacquer, or one which is improperly mixed or applied, is the cause of all the trouble.

Chinese and Japanese lacquers, which produce unusually beautiful finishes, have been used for a great many years and are obtained from certain native trees; in reality they are more like oil varnishes. The ordinary lacquer used in metal finishing is largely a manufactured article and the history of the development of these materials is interesting, recounting as it does the record of a tremendous amount of experiment and research, but space does not permit of a more detailed reference to it. It may be said, however, that the discovery of the action of nitric acid on paper and other forms of cellulose, resulting in the production of compounds known as nitro-celluloses, by the German chemist Schönbein in 1845 was the first step in this evolution. Many years of work were required, however, to develop suitable solvents and otherwise put these compounds in proper shape for use, so the appearance of the modern type of lacquer such as we know it today, dates from about 1882, when John Stevens took out a series of patents for solvents of pyroxylin, certain classes of nitro-cellulose; among these solvents was amyl acetate. Many other solvents have been patented and some of them find a more or less extended use, but amyl acetate, or *banana oil*, continues to hold an important place in the list of such substances. The manufacture of pyroxylin lacquers was started at Springfield, N. J., in 1886, and when the question of the infringement of certain patents developed it resulted in the formation of a company for the manufacture of these products.

Referring to the lacquers used today, these are divided into three general classes, based on their composition: First, we have those containing only some gum in a volatile solvent; second, those which are a solution of pyroxylin in a suitable solvent, and third, lacquers containing both gum and pyroxylin.

The first class, therefore, practically belongs in the list of materials known as spirit varnishes. Resins in solution in amyl acetate or some similar solvent, but free from turpentine or pyroxylin, are known as resin lacquers. The resins usually employed are shellac, copal, sandarac and mastic, given in the order of their relative importance. Damar, amber and the hard copals are soluble only with difficulty in amyl acetate and amyl alcohol, fusel oil, although the solubility is increased by fusing or otherwise treating them. Certain resins, such as elemi and myrrh, which are too soft to be used alone give good results when mixed with sandarac, for example, and some of the softer copals, appearing to increase the elasticity and lessen the brittleness. Some members of the class of substances known as balsams, such as Peru, storax, tolu, etc., are still softer and are also used with other resins to produce a tough film.

Origin of Resins and Gums

It may be interesting to consider briefly the origin of some of the more widely used resins and gums. Gum shellac is as exudation which appears on several eastern trees, following the sting of certain insects which lay their eggs in and are themselves enveloped by the sticky mass. This is collected and refined by melting and straining through cloth, afterward pouring it over a cold metallic or other surface. If desired, it may be bleached later and made the basis of a white varnish. Shellac is more or less soluble in several liquids, but is perhaps most widely used in alcoholic solution.

Copal is a term which is rather loosely used to designate a number of resins, both hard and soft, which are obtained from some of the eastern and tropical countries. The soft copals, which are of importance in lacquer manufacture, are the prod-

ucts of living trees, but the hard varieties are of fossil or recent fossil origin, that is, they were formed and perhaps have been buried in the earth for many hundreds of years. All are of a vitreous appearance, transparent and of a yellow or reddish color.

On the whole, copal is the cheapest of the resins used in lacquer making and it finds extensive use on the cheaper classes of work, such as tags, fruit cans, and so on, generally being mixed with aniline dyes, to produce any desired color.

Sandarac is as hard as kauri copal and in some ways possesses even more desirable qualities. It exudes from the bark of a tree growing in Africa and is readily soluble in the common alcohols, wood, grain and amyl, less so in amyl acetate and only slightly soluble in benzol and benzine, a fact which is used to advantage in making lacquers to produce a frosted effect on glass. By dissolving a resin in a low boiling point solvent, that is, one which evaporates quickly, and adding to this solution a non-solvent which evaporates but slowly, it is clear that when such a lacquer is applied to glass or a metallic surface the more volatile liquid will pass off first, leaving the one which is not so volatile. The resin, not being soluble in this, is slowly precipitated out. Copal, mastic and damar have been found unsatisfactory for this purpose inasmuch as they do not adhere very strongly, but sandarac seems to do very well, producing a hard, opaque film closely resembling ground glass.

Mastic is also an exudation from a tree native to the east, but does not find a very wide use in lacquers, although it is employed to some extent in bronzing liquids.

Applying Resin Lacquers

As a class, resin lacquers are applied by brushing, owing to the large amount of total solids in solution; these range from one to four pounds per gallon. A good resin lacquer will stand brushing out without leaving any marks, will dry without artificial heat and will exhibit a high gloss. One objection to their use is that all of these resins contain varying amounts of certain organic acids which are liable to attack metallic surfaces, such as copper, and cause blackening, unless care is taken to reduce the acidity as much as possible. In general, they can be mixed in all proportions with pyroxylin solutions, using properly selected solvents.

Shellac produces a useful and widely employed lacquer which gives good satisfaction for many purposes and a large variety of parts is finished with it. The so-called French bedstead lacquers are made from highly refined and bleached shellac in grain alcohol, a sufficient amount of various vegetable dyes being added to produce the desired color, usually some shade of gold. The lacquer is brushed onto the cold part, which is then heated in an oven to a temperature of approximately 80 degrees Cent. for about 30 minutes, the result being a hard and brilliant finish.

The fact that shellac possesses a high co-efficient of expansion is made use of in burning-off lacquers, which usually contain wood alcohol, benzine, and a small amount of fusel oil. The parts are immersed in the lacquer or the latter is applied with a brush, then touched with a flame and the solvent is allowed to burn off, whereby enough heat is generated to melt or soften the shellac. Upon cooling, this contracts and forms a strong, hard film. Somewhat along these lines is the practice of buffing and polishing a shellac lacquer until the coating softens and partially fuses under the heat.

Properties of Pyroxylin Lacquers

Before the pyroxylin lacquers can be discussed it will be necessary to consider the process of manufacture and properties of this material. The substance known as cellulose constitutes the structural basis of a plant, the fibre, etc., but by far the larger part of the substances used for nitrating and application along industrial lines consists of cotton in some form or other, which in turn contains about 90 per cent of cellulose, when in the raw state. Ordinary cotton waste from the various mills is the form in which it is most widely used at present for this purpose. In the manufacture of explosives and the higher nitrated products, a little different type of material is employed, while a special kind of paper finds a wide use.

After being thoroughly cleaned, freed from grease and foreign substances and subjected to certain treatments, which are necessary or desirable, the waste is immersed in a mixture of nitric and sulphuric acids. There are several different methods of doing this, but the result in all cases is the same; a series of chemical reactions take place wherein the cellulose acquires anywhere from two to six molecules of a nitrogen and oxygen compound, thereby markedly altering its character in some respects. The length of time and the temperature of the mixture depend on the product desired. Long nitration with strong acid, at rather low temperatures, gives the higher nitrated materials, guncotton, for example, while proper regulation of the process gives substances containing less nitro groups and known as pyroxylin, used in making lacquers, collodion, celluloid and the like.

When the action has proceeded as long as desired, the cotton is taken out of the acid and the excess of the latter is removed by centrifuging, following which it is thoroughly washed in cold water. This in turn is displaced by some solvent, denatured ethyl alcohol or propyl alcohol, or the mass is subjected to great pressure in order to drive out the remaining water.

It may be stated that the finest and whitest lacquers, used on silverware, are produced by nitrating tissue paper, but the process, in the main, is as described.

It is impossible to go into the question of pyroxylin solvents very deeply here, but it may be remarked that pyroxylin is soluble in a number of liquids, some of which are comparatively expensive, especially since the war began; consequently, the selection of the proper one for the purpose in hand and its dilution to the greatest permissible extent is an important problem. To produce the proper adjustment of the constituents of a lacquer or thinner, requires much skill and experience. Thus, amyl acetate is an excellent solvent for pyroxylin, but just now is scarce and costly; therefore, benzine, which is comparatively cheap, but a non-solvent, is added in as great a proportion as permissible, stopping just short of actual precipitation of the pyroxylin from the solution. Other liquids are added for various reasons, but the amount of high-boiling and low-boiling liquids must be so arranged that the film will dry at the proper rate to make it smooth and free from wrinkles.

Pyroxylin Lacquers

A pyroxylin lacquer is nothing more than a solution of this substance, perhaps five or six ounces per gallon, in a suitable solvent and usually is shipped to the customer too heavy for use, requiring to be diluted with the thinner, which is of about the same composition as the solvent portion of the lacquer. From what has been said it can easily be seen that substituting one thinner for another or using a home-made variety is liable to result disastrously, and unless one has an intimate knowledge of the subject it should not be attempted.

Before using, the lacquer is thinned until it is of the proper consistency which, in the last analysis, depends on the film produced. Generally, the dilution is continued until the dried film iridesces or assumes rainbow

tints, then a little unthinned lacquer is added to the thinned portion and the whole is ready for use. It may be that the film produced before this point is reached is deficient in strength or too thin for the purpose desired, so this quality may be made the criterion and the addition of thinner stopped when the film fails to meet certain tests. It is economy, of course, to use as much thinner as possible, consistent with good work, since it is cheaper than the lacquer and there is the further consideration that a very thin coat of lacquer is less liable to give a white metal, such as silver or nickel, a yellow tinge, so the lacquer is thinned to the last degree. Sometimes a very small amount of resin, shellac for example, is added to decrease the liability to iridesce, thereby permitting thinner films.

These preparations find a large variety of uses in other lines as well as in metal finishing and are applied by brushing, dipping, or spraying, depending on the character of the work. After lacquering, the parts generally are placed in a warm room or drying cabinet and gently heated for a time to hasten thorough evaporation of the solvent and hardening of the film. For many purposes a colored lacquer is preferred to a clear, white one, to give a richer color to a metal. In such cases aniline dyes are dissolved in a suitable solvent such as wood alcohol, acetone, amyl acetate, etc., and added to the lacquer.

On the whole, pyroxylin lacquers give a thin, smooth and elastic film, which does not change the appearance of the metal surface very much, as a good lacquer is nearly invisible.

Pyroxylin-Resin Lacquers

The pyroxylin-resin lacquers possess superior qualities to either of the classes previously considered, and therefore permit of a much wider range of usefulness. This is only natural since by combining two or more materials the good qualities of each may be emphasized. Thus hardness and covering power may be increased without augmenting the flow, and so on. The combinations of pyroxylin and shellac are probably the most extensively used, although other resins and combinations of these also are employed. The composition of most lacquers cannot be very definitely stated since this depends on the nature of the work and the requirements of the finish. In a general way, a lacquer possessing almost any desired qualities can be produced by the proper selection of the solids, pyroxylin and resins, and their solvents.

These, as well as the straight resin lacquers, are applied by brushing or spraying and are used largely for the purpose of ornamentation, in distinction to the pure pyroxylin variety which is intended mostly for protection. Mixed with various colored pigments, they can be used for the production of an infinite variety of finishes such as weathered and antique effects, dull and high gloss blacks, etc.

Bronzing and Gilding Liquids

Bronzing and gilding liquids may be briefly mentioned, since some of these are made up on a pyroxylin base and contain a small amount of resin. When needed for use, a quantity of finely divided metal of the desired color is stirred into the liquid which is then applied, usually with a brush. They are used for gilding a large variety of ornamental work, picture frames, statuary and the like, and also for coating steam and water pipes, radiators, etc.

This article would hardly be complete without some reference to a certain class of lacquers and other materials known broadly by the term *phenol condensation products,* which have come on the market during the last few years. The reactions which take place when phenol, carbolic acid, and formic aldehyde are allowed to act on each other under the proper conditions result in the formation of various compounds which possess some unique qualities, and perhaps the best known of these is bakelite, named after its discoverer, Dr. Leo Baekeland. This may be obtained as a clear liquid permitting of application to metal and other parts in the same way as other finishing materials; when subjected to heat, the bakelite dries to a fairly hard film, which may be made still harder by the application of a higher degree of heat. The most interesting point about it, however, is that the solid material is stable toward acids, alkalis and other destructive agents; therefore, it would seem that it could be used to good advantage in cases where an exceptionally resistant finish is required.

The ordinary resin-and-pyroxylin lacquers have many good points in their favor and it would be very hard to get along without them, but they have their weaknesses also, so it is highly probable that they will be replaced for certain purposes, at least to a limited extent, by some of the newer finishing media which are of entirely different composition and properties.

The co-partnership of Fuller & Smith, Cleveland, advertising writers and counsellors, has been changed to an incorporated company without change in the firm name. The incorporators are Harry Dwight Smith, president; Fred R. Fuller, vice president and treasurer; Norman Craig, vice president; A. Judson, secretary; P. W. Murphy, secretary to the president; C. L. Madden and C. E. Horton. Except in minor details, the organization and method of handling the business will remain the same.

Foundry Equipment Co. Extends Plant

The plant of the Foundry Equipment Co., Cleveland, has been removed from 2102-2118 Abbey avenue to 1831 Columbus road and Girard avenue. Two large, well-lighted and well-ventilated factory buildings, formerly occupied by the U. S. Bronze Co. and the Standard Brass Co., have been purchased, which insure ample manufacturing and warehouse facilities. The company manufactures a complete line of foundry equipment, including core and mold ovens, core and mold cars, brass and aluminum furnaces, hand squeezers, water tumblers, sprue cutters, oil burners, crucible lifters, etc. A foundry engineering department also is maintained, which specializes in the design of foundries and other industrial plants. F. A. Coleman, formerly president and J. D. Smith Foundry Supply Co., and the Coleman Foundry Equipment Co., is general manager of the Foundry Equipment Co. and is in direct charge of the design of the complete line of equipment which it manufactures.

Westinghouse Company Will Build

The Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., recently has purchased a plot of ground at Essington, near Philadelphia, which embraces about 500 acres with a frontage of approximately one mile on the Delaware river. Additional transportation facilities will be afforded by tracks from the Pennsylvania and Philadelphia & Reading railroads. This new center will be devoted to the production of large apparatus, the first group of buildings being for power machinery, such as steam turbines, condensers and reduction gears. The initial development will cost approximately $6,000,000 and the buildings will occupy about one-fifth of the area of the entire plot. This group will consist of the following structures: Two large machine shops, erecting shop for heavy machinery, forge shop, pattern shop and pattern storage and power house.

The Gulick-Henderson Co., engineer, chemist, assayer and metallurgist, has consolidated its general office in New York City, located at 30 Church street and 120 Broadway, respectively, and has removed them to suite 1932-1939, 13-21 Park Row.

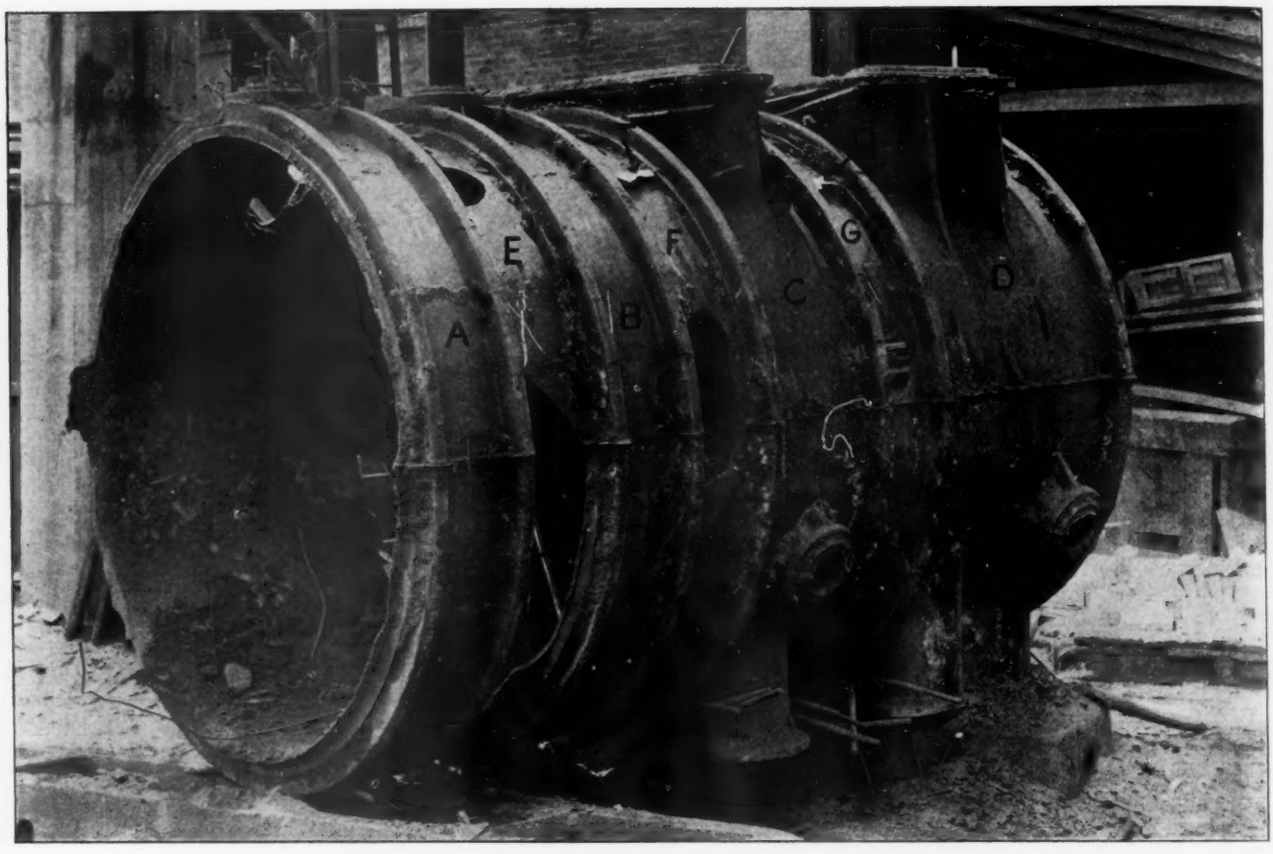


FIG. 1—AMMONIA STILL SECTIONS IN THE CLEANING YARD READY TO BE BROKEN APART

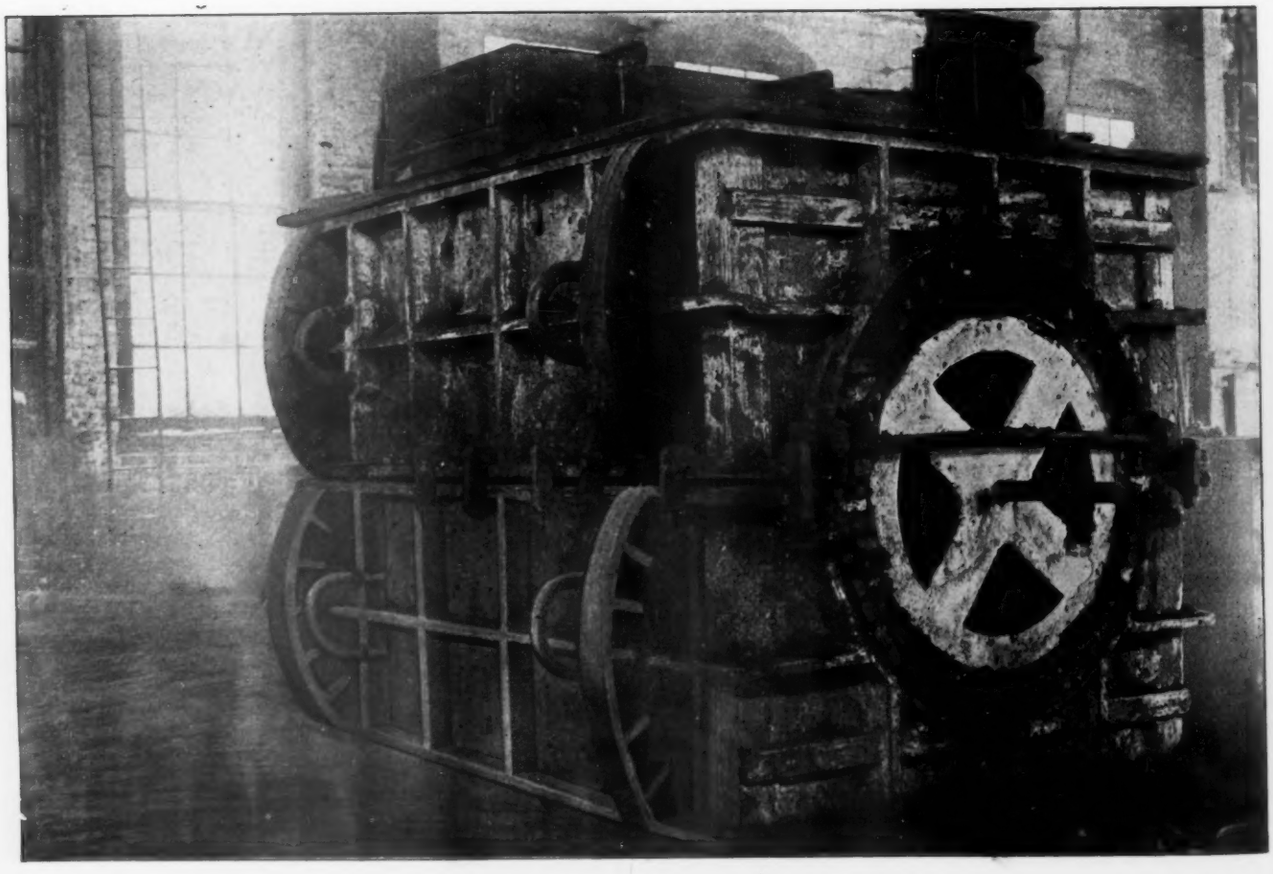


FIG. 2—THE MOLD ASSEMBLED READY FOR POURING

How Heavy Ammonia Stills Are Molded

A Novel Method of Molding Enabled the Hooven-Ovens-Rentschler Co. to Double Production on a Limited Floor Area

IN TIMES like the present, when every inch of shop floor space is constantly in demand, foundrymen are encouraged to exercise their ingenuity in devising new methods of obtaining a maximum tonnage with minimum facilities. The superintendent who realizes 50 per cent in excess of the production usually expected from his shop, without waiting to make extensive additions to his buildings or equipment, is valued highly when business is moving forward rapidly. If he can achieve this increased production without materially adding to his costs, the pinnacle of efficiency is approached.

As an example of what can be done in handling an excessive tonnage of heavy castings with ordinary apparatus, the methods pursued in the shop of the Hooven-Owens-Rentschler Co., Hamilton, O., are worthy of study. This plant is operated under the direction of James A. Murphy, foundry superintendent. The molding floor is 70 x 400 feet and the melting equipment includes three cupolas with a combined capacity of 51 tons per hour. With these facilities a great variety of heavy castings are produced, including massive bed plates for rolling mill engines, large flywheels, heavy cylinders, etc.

Recently this foundry was called upon to make a large number of cast iron sections for ammonia stills for installation in connection with by-product coke oven plants. These sections are nothing more than flanged rings 70½ inches in inside diameter, and vary from 16 to 42 inches in length between flanges. Some of the larger sections are provided with wide-mouthed flanged outlet connections which complicate the casting.

How the Production was Doubled

Under ordinary circumstances these rings or sections, which vary in weight from 1¼ to 3 tons, would be molded horizontally on the floor in separate flasks of various sizes. But in order to turn out any considerable number of rings rapidly by this method, a large floor space would be necessary, together with extensive flask equipment. In handling this work in the Hooven-Owens-Rentschler foundry, Mr. Murphy was confronted with the problem of obtaining at least a dozen castings a week without interfering with the large amount of other work going through the shop. It was necessary, therefore, to devise some method of materially curtailing the floor area occupied by the job. Also, it was equally necessary to speed the production up to the limit in order to get the work out of the way as quickly as possible and make room for subsequent jobs.

The problem was solved by molding and casting two of the larger and two of the smaller sections as one piece in a heavy cast iron flask, using a single pattern. This was readily accomplished by placing the sections together so that they formed a large pipe or cylinder. In order to facilitate the separation of the individual castings, the sections were connected by thin rings or fins of metal which were easily broken out in the cleaning yard.

One of the complete castings made by this method is shown in Fig. 1. The ammonia still sections are shown at *A, B, C,* and *D* in this illustration, separated by the connecting rings *E, F* and *G*. Portions of these rings already have been knocked out in order to free the castings from one another.

The rough castings weigh 7½ tons. The two smaller sections, shown at the left in Fig. 1, which are 16 inches in length, weigh 2,500 pounds apiece. The middle section, which is 23 inches in length, weighs 4,500 pounds. The section at the extreme right end of the casting, which is 42 inches in length, weighs 6,500 pounds. Each section is 70½ inches in diameter inside. The flanges are about 2¼ inches wide and one-inch thick.

The pattern, which is wood, is split axially. The two halves are molded in the cope and drag, respectively, just as if an ordinary small floor job were being handled. The parting line between the two halves of the mold is shown very clearly in Fig. 1.

Using this method of molding, four men turn out three sets of castings per

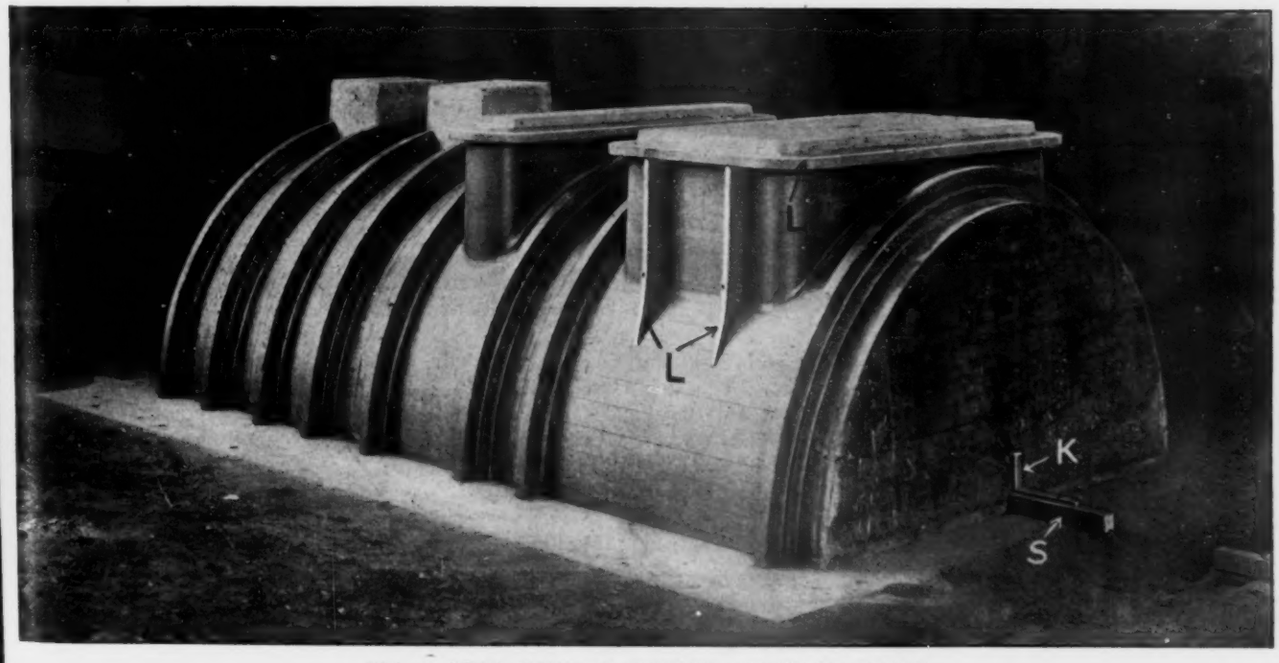


FIG. 3—DRAG HALF OF PATTERN ON FLOOR PLATE

week. The total production, therefore, is six large and six small still sections. In order to attain this production, the four men who work on the job put up a complete flask in two days. Two men work on the cope and the other two on the drag. Another man is employed who spends a day in finishing and closing each mold. It is evident that this method of molding results in at least double the production which could be obtained by molding the sections separately on the floor. The complete mold with the core in place weighs 24 tons.

The method of molding the drag is illustrated clearly in Figs. 3 and 5. The former shows the pattern in its proper place on the bottom-board, and the latter shows the drag after it has been rolled over. In Fig. 5, the cores forming the flanged outlets have been set. The drag, which is of heavy ribbed cast iron construction, is 12 feet long, 8 feet wide and 5 feet in height. A 2-inch square steel web is cast in each end of the drag, across the top of the arch, in order to strengthen it at its weakest points. The bases of the arch are tied together by a 1½-inch wrought iron rod which is provided with a suitable tension adjustment nut.

As shown in Fig. 3, the pattern and flask rest on a heavy cast iron plate set in the floor. This plate, which is 12 feet long and 9 feet wide, serves the purpose of a bottom-board. The upper or exposed surface is planed true. The pattern fits securely over a 2-inch square steel spline which extends the full length of the plate. One end of this spline is shown at *S*, Fig. 3. In order that the pattern may be accurately centered in the flask, a steel bracket, *K*, is bolted to one end of the spline. The pattern is shoved up snugly against this bracket, and is thus centered automatically. The flask pins fit in machined holes in the floor plate.

It is not feasible to jar-ram the mold on account of the various flanges under which the sand must be tucked properly. These flanges and ribs, *L*, Fig. 3, of course are loose and are removed from the mold either before the flask is rolled-over or after the main pattern is drawn.

The mold is rammed entirely by hand. The sand, which is furnished by the Hamilton Molding Sand Co., Hamilton, O., is said to be particularly adapted to heavy gray iron work. The mold is filled with old sand and is faced with a mixture consisting of 50 per cent old and 50 per cent new sand. No special facings are employed.

The general arrangement of the cope portion of the mold is shown in Fig. 6. This illustration shows clearly the heavy rockers cast on the sides of the cope to facilitate rolling it over with the traveling crane. The large eyebolts in which the crane hooks are fastened also are plainly visible. The cope is 12 feet long, 8 feet wide and 5 feet high. Its general construction is similar to that of the drag. The cope is molded over a half pattern, similar to that used for the drag. On account of the flanged outlets on the larger still sections, it is not possible to fit the cope with bars to hold the sand in the ordinary manner. Instead, a heavy cast iron grid, *R*, Fig. 6, is bolted to the top of the cope. The bars of this grid are provided with webs which extend down into the sand for about 2½ inches, thus staying the mold. The grid, of course, is not fastened to the cope until after most of the sand is thoroughly rammed in place. Fig. 6 shows the pouring basin on the top of the cope. This basin, which is constructed of dry sand, connects with six sprues arranged in two groups. The sprues are about 2 inches square and are so placed that they feed two set-gates. The location of the gates is shown clearly at *T*, Fig. 1. It will be observed that one of the smaller still sections, on the extreme end of the casting, is fed entirely through the connecting ring. The gates are made of lead so that they can be readily bent to fit the pattern.

The cope, which is rolled over by the

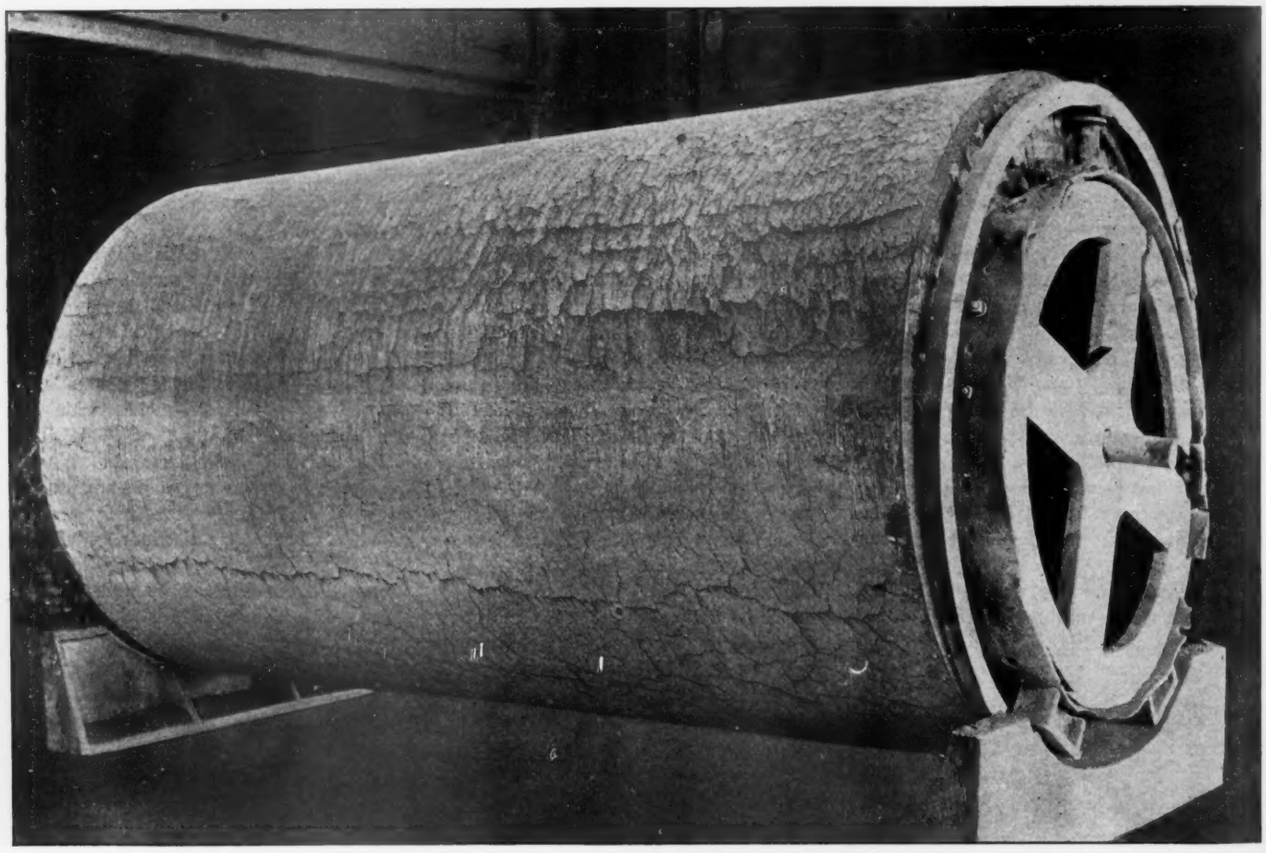


FIG. 4—CORE FINISHED AND BAKED READY TO BE INSERTED IN THE MOLD

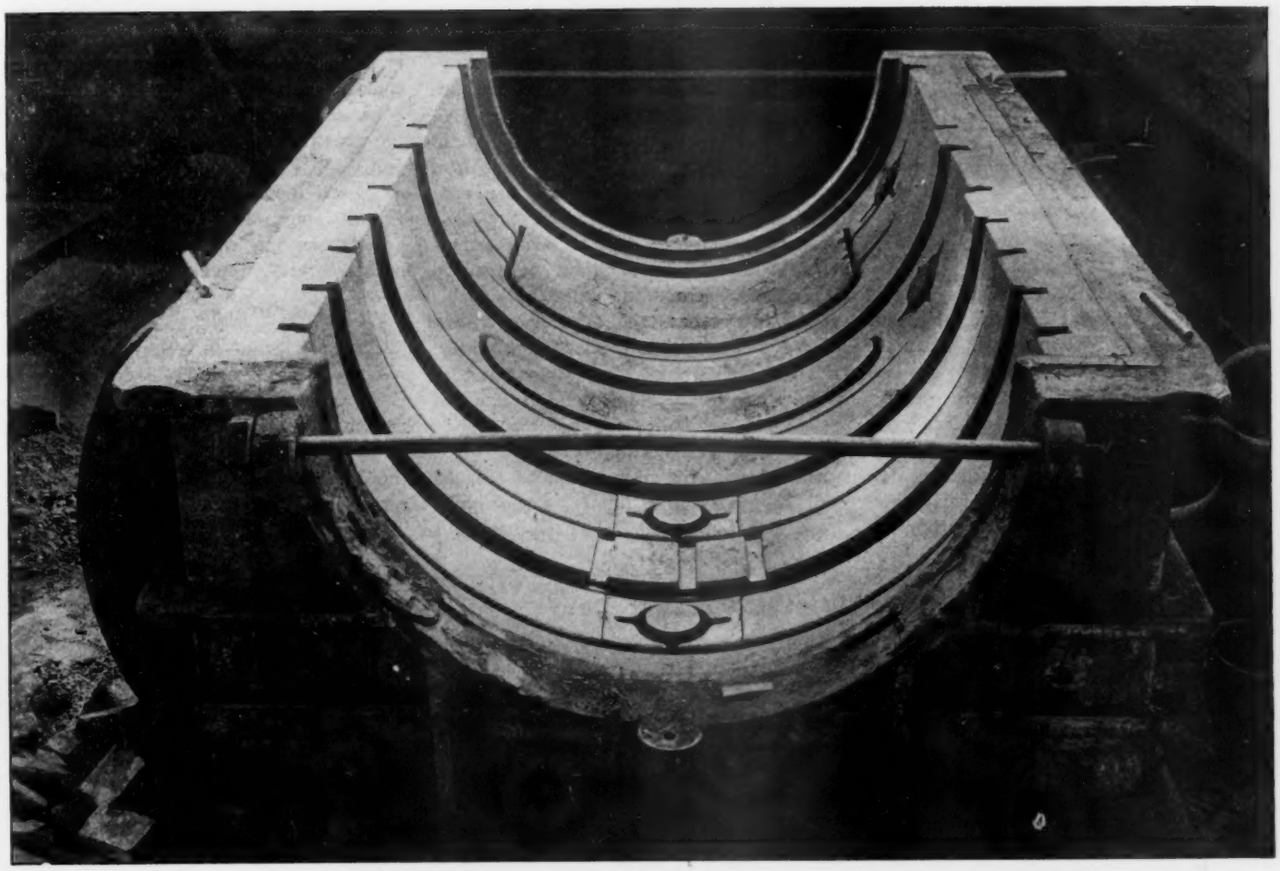


FIG. 5—DRAG MOLD ROLLED OVER AND FINISHED WITH OUTLET PASSAGE CORES SET

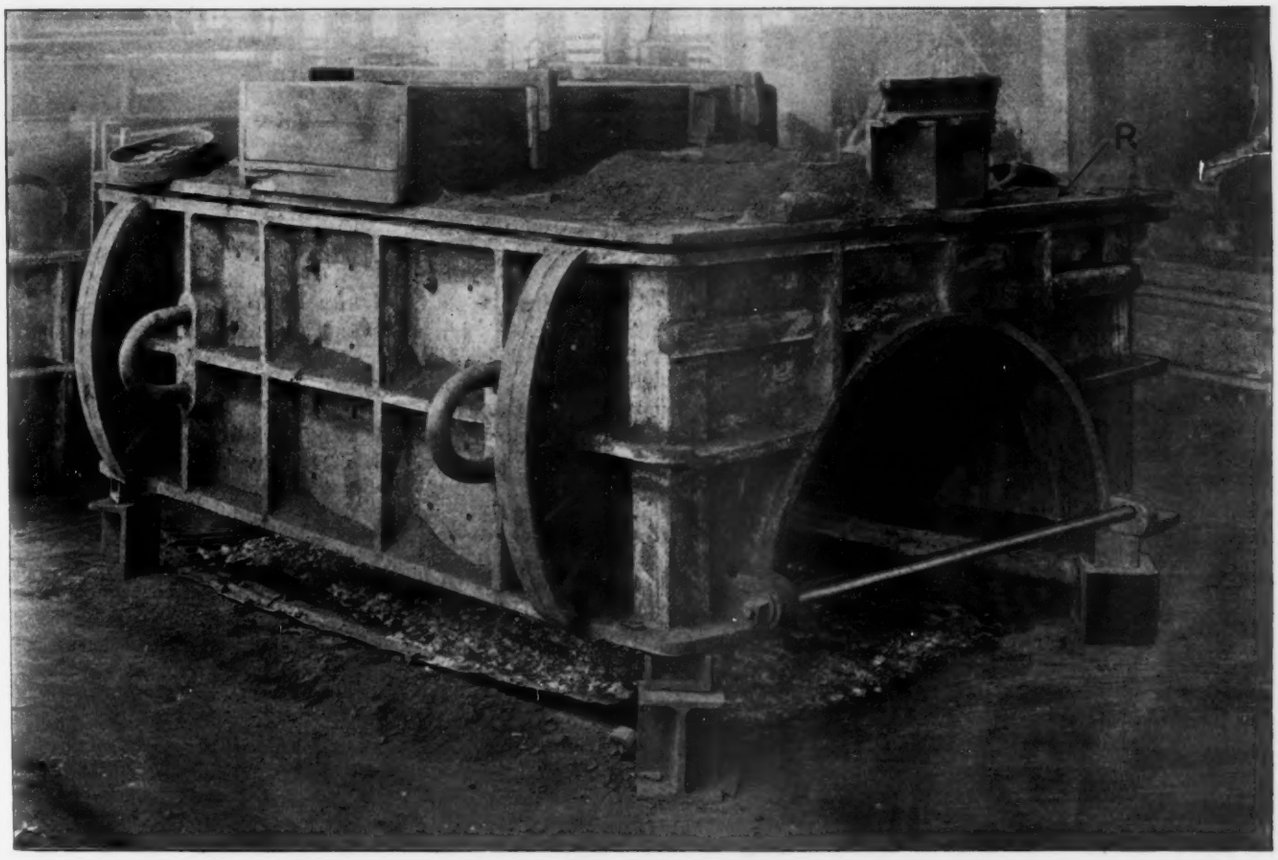


FIG. 6—COPE MOLD ARRANGED FOR SKIN-DRYING WITH CHARCOAL

crane, is set up on blocks for drying with a charcoal fire. Fig. 6 shows the arrangements for drying the cope, which are very simple. The casting is provided with two risers placed at the ends. They are utilized simply for flow-off purposes, there being no special amount of shrinkage to be taken care of.

How the Core is Made

The interior of the casting is formed by a large cylindrical core, Fig. 4. This core, which is 70½ inches in diameter and 10½ feet in length, is made by two men in 8½ hours. The arbor consists simply of four cast iron spiders covered with boiler plate, forming a cylinder about 5 feet in diameter. In order to vent the core properly, the boiler plate covering of the arbor or barrel is pierced with a large number of ½-inch holes.

The arbor is supported between standards as shown in Fig. 7. This illustration shows a corliss engine core that is similar to the ammonia still core. Stop-off boards, *S*, are provided and half the surface of the core is covered with sand. After the sand is properly tucked in place it is struck-off to a true semi-circle by means of a suitable sweep. The core is then placed in the oven and baked. After it is removed it is rotated one-half a revolution and the remainder of the arbor is covered with sand. After this sand has been properly struck-off, the core is placed in the oven a second time for its final baking. This double baking is necessary because the green sand will not adhere to the arbor when the care is rolled over. As shown in Fig. 4, the arbor is set eccentrically in the core, the sand being 3 inches in thickness on the bottom and 8 inches on the top. This is done in order to make it certain that the hanging sand on the bottom will not fall off. Both ends of the core are protected by rings of fire brick which hold the sand in place. The large cast iron rings shown at the ends of the core in Fig. 4 are used to stop-off the sand properly when the core is being swept-up. Although this method of making large barrel cores may not be considered ideal, it has the advantage of simplicity and is economical of equipment.

The finished mold, ready to pour, is shown in Fig. 2. The metal is handled in an 8½-ton ladle, about 1,000 pounds of excess iron being provided. For melting this iron three cupolas, 54, 66 and 72 inches in diameter, respectively, have been provided. The 54-inch and 66-inch cupolas were built by the Whiting Foundry Equipment Co., Harvey, Ill. The 72-inch cupola was built by the Hooven-Owens-Rentschler Co. The mixture is so proportioned that the metal in the casting will contain approximately 1.65 per cent silicon, under 0.09 per cent sulphur, 0.55 to 0.60 per cent manganese and 0.60 per cent phosphorus. The actual mixtures of pig iron and scrap used to obtain these results vary according to market conditions and the grades of pig iron on hand.

Mixture Heavy in Pig Iron

In general, an effort is made to use a mixture heavy in pig iron and for this purpose a considerable proportion of No. 4 foundry iron is purchased and used in place of scrap. Some of this low grade pig iron contains only 0.66 per cent silicon with 0.116 per cent sulphur and 1.17 per cent phosphorus. A liberal proportion of steel scrap also is utilized to give the casting suitable characteristics.

In order to give a concrete idea of the mixture it may be stated that on June 13, each cupola charge consisted of 1,600 pounds of No. 2 northern foundry pig iron, 1,400 pounds of No. 4 northern pig iron, and 1,000 pounds of steel rail croppings.

Charging Fuel and Iron

The pig iron for these charges is piled on the charging floor in layers, each charge being separated from its neighbors by a heavy wire. This arrangement saves considerable time when the heat is being taken off. The steel scrap is weighed on a platform scale. The coke is not weighed, it being estimated that a fork full weighs 20 pounds. Some of the mixtures contain cast-iron borings which are packed in cartridges made from second-grade stove pipe. Each cartridge is about 6 inches in diameter and 2 feet long, weighing approximately 50 pounds. It is estimated that it costs $2 per ton to prepare the borings in this manner, and the melting loss is said to be practically negligible.

After the casting is taken out of the sand and transferred to the yard for cleaning, the core is removed by hydraulic methods, as previously described in *The Foundry*. The bricks which hold the ends of the core in place are first removed, after which the sand may be easily sluiced out from between the casting and the arbor with a 1½-inch hose stream. The water is supplied to the hose at a pressure of 250 pounds per square inch.

FIG. 7—HALF OF THE BARREL CORE IS SWEPT UP AT ONE TIME

What Foundrymen Can Do to Prevent Hot Boxes

Careful Attention to Journal Bearings in the Foundry Will Result in a Reduced Number of Failures on the Road

By Russell R Clarke

IN RAILROAD parlance, a hot box is an expression for a hot-running journal. Railroad motive power difficulties are not a few. Of its constants of service-opposing circumstances none are more faithfully prevalent than this hot box. Neither are there many inviting greater seriousness of result. Greatest consequences are always germane to it, materializing in impaired journals, wheels, journal boxes, wedges and car underwork, all of which argue more or less persuasively to that greatest of all railroad evils, namely the railroad wreck. In the very premises, then, the elimination of the hot box is elementary to transportation efficiency and always a live issue in railroad circles.

The hot box never invades a mystery of condition beyond explanation. It is always an effect following some definite cause or combination thereof. Otherwise, one of two conditions would be inevitable, either all bearings would run hot or none. That some do run hot derives its origin from a variety of causes either singly or conjunctively operative. Among these causes the following are mainly prominent: Improper composition of alloys, bad foundry practice in manipulation, inferior grade of material, a tight fitting of the bearing in either the wedge or on the journal, porosity of the lead-base lining metal, rough or abrased bearing surfaces, uneven surfaces in either the wedge or the back of the bearing, loose linings, excessive bearing surface, boring and lining the bearing out of line with its longitudinal center, poverty of lubricant, unequal distribution of load, inadequate protection against dust and grime and infrequent renewal of box packing. From this it will be seen that including the design of the bearing, its boring and its lining, at least 70 per cent of these evil-producing causes trace their sources to the foundry and challenge most justly its remedial considerations.

These considerations are the concern of this article. In those items of prevention beyond foundry jurisdiction to regulate, such as lubrication, renewal of packing, etc., we are at present interested only to the degree of remarking that their far-reaching influence invades no province of doubt, that they are the presumed and requisite assets of good service, that no bearing, regardless of its quality, can operate efficiently for any length of time unaided by them and that in dealing with an acute situation of hot boxes, their consideration as a probable source of difficulty is as logical as the spontaneous and proof-bereft conclusion of responsibility on the part of the foundry. To be concretely explicit, you can't blame the foundry for a hot box if a car inspector drops bits of oil-soaked waste on the ground and then pokes them into the journal box without thoroughly cleaning them. A common contention is that 90 per cent of the oil used in these boxes is wasted. If this be so, the foundry is not altogether without some mitigating evidence.

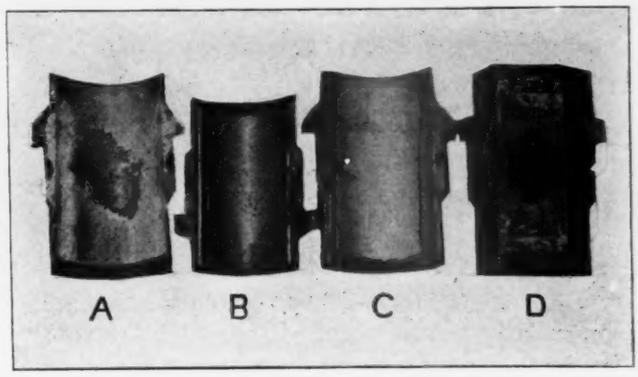


FIG. 1—FOUNDRY CAUSES OF HOT-RUNNING JOURNALS
A bare spot in tinning, causing loose lining; *B* porous lining metal; *C* lined out of line with longitudinal center; *D* swell in the back, shown by dark spot.

The modern railroad journal bearing is a composite affair consisting of a solid back of copper-base metal supplemented on its journal-facing side with a lining metal of lead base. It is commonly referred to in railroad parlance as a lead-lined bearing. Several common types of bearings are illustrated in Fig. 2.

The journal box wedge is a ferrous casting saddling the back of the bearing and occurring in the upper inside position of the box. The shape of the M. C. B. A. bearing back is of the trapezoid type. That of the wedge is similar, though slightly larger in dimensions to insure a crown-resting condition and thus obviate bending. If by any inconsistency in either bearing design or foundry practice the above conditions be reversed, the inevitable result is a pinching of the bearing sides in the wedge to which a breaking of the bearing or its tightening on the journal at the bearing's lower edges are invariably possible. This lower-edge-tightening effect seldom fails to produce a hot box and most logically so. The conditions are pre-eminently in favor of it. By it the area of pressure and bearing surface are reduced, localized and consequently intensified. To make matters worse, the wiping effect of the tight-fitting edge practically eliminates the lubricant, always supplied from the underside, from the bearing surfaces. Now it is the business of the foundrymen to see to it that these conditions do not arise which presupposes frequent checking of patterns and a rigid inspection of all bearings produced covering assurance of their true form and strict conformity to gage. Incidentally, the gages themselves should come in for frequent checking since by constant use some of them wear quite rapidly.

This same tightening of the bearing on the journal and its consequences follow the practice of lining the bearing on a mandrel-radius exactly equal to or less than that of the journal. A still further source identifies with the inconsistency of boring and lining the bearing out of line with its longitudinal center giving the bearing an out-of-line, twisting position on the journal and resulting in the same localized intensity of wear and pressure. This condition is shown at *C*, Fig. 1. In its position both in the wedge and on the journal, the bearing composite is figured to observe the crown bearing principle. Calculations on bearing surface, clearance, rocking space, etc., though always liberal, are never free from indiscriminate violation and foundries producing this class of work should keep steadily in mind that inefficiency in service may

often result from the actual seriousness of an apparent insignificance. Still further important in this connection is the rectangular crown of the bearing back. A straight-edge test should always be made and show it to be a perfectly level surface. If swelled either uniformly or abruptly, as indicated at *D*, Fig. 1, it permits rocking and favors localized pressure intensity. The well-regulated shrinkage cavity in this crown back need not necessarily occasion the bearing's rejection, since there are types of bearings thus purposely cast to conserve metal. The unnatural cavity or depression, however, calls for best inspecting judgment, since a pattern-created and a molding-occasioned depression in a casting are entirely different propositions.

The composition of the copper-base should at least approximate that of a bearing metal. The wear of the journal collars on either end of the bearings in use today. Present-day tendency leans perceptibly to the junk bearing, an affair against which the author has a strengthening conviction. From a car of returned scrap, 50 badly crushed and mutilated bearings were indiscriminately selected by a man having no knowledge of the object of the procedure. The author went over these bearings and found 42 of them to be what he positively knew them to be, namely, junk-pot creations.

In dismissing this feature of the discussion, we might profitably remark that in their tentative specifications for non-ferrous locomotive equipment, the American Society for Testing Materials submitted two mixes for consideration in journal bearing connection. These mixes are referred to as bearing metal No. 3 and bearing metal No. 4, and read respectively as follows: Tin, 7 to 9 per cent; lead, 14 to 16 per cent; zinc, 3 per cent maximum, balance copper, and tin, 4 to 6 per cent; lead, 15 to 20 per cent; zinc 5 per cent maximum and balance copper. The author does not hesitate to record his opinion in favor of the No. 3 specification, which approximates the 78 copper, 7 tin, lead 15 alloy with zinc accommodations. No. 4 mixture bases practically on copper 72, tin 5, zinc 5, lead 18. The white metal lining is usually a combination of lead and antimony. As determined by Ralfe, the true alloy of these elements in combination shows lead 87 and antimony 13 per cent. An advance in the latter element beyond this figure shows particles of free antimony set in a groundmass of the eutectic. The nature of antimony is well known to be hard and extremely brittle, so that small particles in isolation near the bearing surface would open the possibility of their crushing and dislodging under the hard strains of service, resulting in a powdered metallic mixing with the lubricant and a mechanical porosity in the bearing surface, both of which are polar to good service conditions. Inclusion of a hard in a ground mass of softer material may be a good thing in some fields of bearing service, but in any so severe as the railroad journal bearing, we seriously question its wisdom. At any rate, as a hardening agent 13 per cent of antimony is ample for the occasion and yields a very satisfactory and, under normal market conditions, cheap lining metal.

With respect to the tentative specifications, as submitted by the American Society for Testing Materials, we call attention to the composition recommended for this metal, which reads as follows: Copper, 0.5 per cent maximum; tin, 4 to 6 per cent; zinc, 0.10 per cent maximum, antimony 9 to 11 per cent, and the balance, lead. This mix is practically based on lead, 85 per cent; tin, 5 per cent, and antimony, 10 per cent, which under normal market conditions must be admitted a comparatively expensive lining material in view of the great quantities requisite to railroad service demands. On its merits we possess no reliable data, but can see nothing in the premises to militate against its efficiency unless it be the zinc permitted. It goes without saying that in any lead-antimony bearing combination, reputable brands of virgin material are essential to high-class service. Especially is this true in the case of the antimony, where the margin of quality between a cheap and dearer grade is so wide. Cookson's antimony, of course, will give maximum results, though so sterling a brand cannot be said to be absolutely necessary to the demands of the occasion. However, when you slide too far down the scale and register in the zone of the cheap Hungarian brands, you can always look for more or less service dissatisfaction. The happy medium is the essential to creditable results at reasonable expense.

Manipulation of scrap along with new material is permissible, but presupposes enlightened common sense

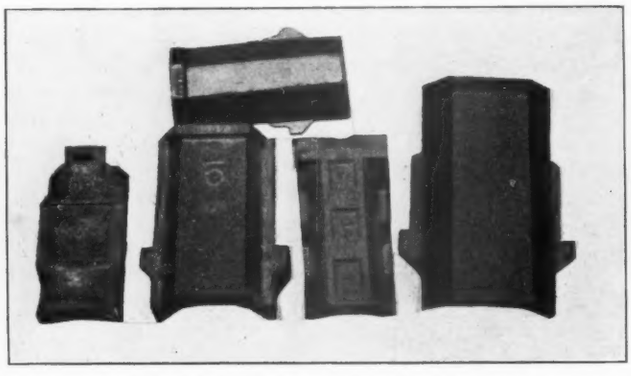


FIG. 2—A FEW OF THE MANY TYPES OF RAILROAD CAR JOURNAL BEARINGS

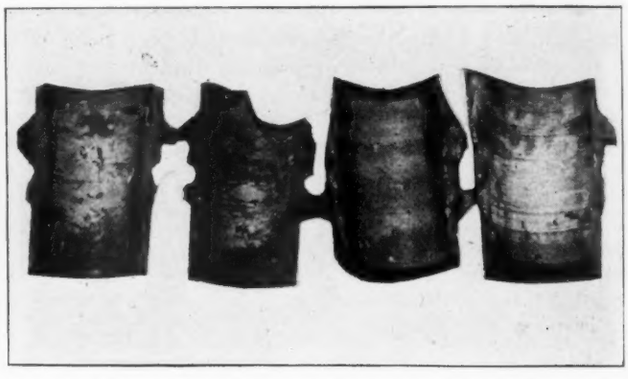


FIG. 3—TROUBLE-MAKING JOURNAL BEARINGS REMOVED FROM CARS

ing alone warrant this consideration while the amply service-proven fact of the oft-imposed necessity of the journal to resort to the naked brass altogether, as its bearing metal gives additional force to the argument. An impressive observation in examining returned scrap bearings is that in many such cases evidences of most serious hot-box conditions are seldom lacking. It is admitted, of course, that the heated condition may have preceded journal-with-brass association and been responsible for it in a number of cases, though the opposite is quite as logical and evidence-warranted to assume in as many instances. Copper-tin-lead with a minimum of zinc is doubtless the logical combination though as has been ably and justly brought out by G. H. Clamer, of the Ajax Metal Co., that in formulating and recommending a standard mix for this purpose, some provision will have to be made for a while at least to permit the railroads service disposition of scrap from the great bulk of badly zinc-contaminated

and sterling judgment and practice in governing control. All scrap lining metal suffers one combining melting and at least three remeltings before re-entering the service from which it came as a scrap metal. Our experience has been that no antimonial-lead can go through these from four to five processes and retain its quality unimpaired. In scrap form, the lining metal is returned with the bearing and usually clinging to it. The mass of bearings are thrown into a large burning-off pot and the lining metal melted off. By melting off in large quantity, carefully controling the temperature to avoid burning, pigging and analyzing each lot separately and figuring it in small quantities into and along with new material, the situation can be satisfactorily controled and the scrap disposed of. An exemplary composition of one of these lots as analytically determined reads lead, 85.75 per cent; tin, 2.53 per cent, and antimony, 11.79 per cent. A good practice that can be resorted to for purifying this scrap metal consists in immersing a good sized block of dry hickory wood in the pot, allowing the metal to boil 15 or 20 minutes and skimming the dross from the surface as it develops.

Melting the Metal

In process of combining its constituent elements and in manipulation, this lining metal should be accorded the same sterling practice. Overheating the metal in any stage makes it hard, brittle and oxide-including, all of which are on intimate terms with the hot-running journal. In this, as in every other field of non-ferrous service, the oxide evil is one of the most detrimental to results and embodies in its seriousness the great necessity for well-regulated precaution against its development. Correlatively we might remark that the same consideration applies to the copper-base alloy used in the bearing back. In manufacturing the lining alloy from its elements, two reputable practices are admissible. The first is to melt first in the iron pot a quantity of lead equal to the antimony to be used, crush this into small pieces, add it to the lead bath and cover with crushed charcoal while it slowly melts. At complete dissolution, add the remainder of the lead, stir thoroughly and pig. The other method, which is the quicker and better, consists of melting the elements separately, the lead in the iron pot and the antimony in a crucible, and combining them in their liquid state. In either case, superheating must be carefully guarded against.

Exaggerated porosity in the lining metal is a prevalent source of hot-box trouble. Surface-occurring, as shown in *B*, Fig. 1, these little cavities become receptacles of collecting dirt and grime which harden in them and attack the revolving journal. The consequence is the journal is scored and the hot box at once dickered with. From the very beginning it must be understood that smooth surfaces in both bearing and journal are alone inherently capacitated to repel the inroads of friction as recorded in heat. Sources of this porosity are varied. It may occur from overheating the metal, from pouring it at improper temperature, from a chilled mandrel, a steaming bearing back at time of pouring or from bad metal. It can follow also an oxidized lining surface in the bearing back. The steaming of the back and its oxidized bearing surface are the only items calling for comment. Paradoxical as it may appear, a water-soaked bearing is a possibility. It very often follows shaking castings out at high temperature and immersing them in water, as in tumbling barrel operation. Following this practice, we have known bearings even after boring and then tinned and preheated, to steam perceptibly and blow the filling metal back out when poured into the opening between the bearing and the mandrel. On one occasion we were having this trouble and to make definitely sure of its source, had 50 bearings from the same metal as that giving trouble left in the mold until completely cold. In lining, not one of these 50 observed a blowing tendency. It is quite easy to connect the steaming of the surface with the porosity of the lining metal. The presence of included oxides or oxidized metal will produce a similar effect and behaves much the same as rust on iron. The lining metal observes a revolting attitude to the oxide's presence and records its displeasure in agitation throughout solidification with porosity resulting.

Loose Bearings Cause Trouble

In service, the loose bearing very often parts with its lining and imposes on the copper-base metal back a task to which it was never fully intended. It makes possible also a crushing-rolling up, a sort of a buckling of the lining metal. Many returned scrap bearings offer strong evidence of this condition to which heat development is always a probability. Binding and cramping follow with a still greater heating possibility. As with porosity, the loose bearing is a cause-varying consequence among which the following are significant: Dull tools in boring, improper and imperfect tinning, as indicated in *A*, Fig. 1, pouring the bearing when the bearing is in too cold a condition, permitting too long a time to intervene between boring and lining, pouring the lining metal too cold, poor grade or bad composition-ratio in tinning alloy, steaming of the bearing while pouring, oxidized tinning surface, and rough handling of the lined bearing in both heated and cold condition. A few remarks will suffice to point out the more important of these. Dull tools in boring seldom produce a clean cut. Instead, they merely bruise the rough surface, leaving it in no condition to tin properly. In tinning, best grade of material should be used and when tin and lead are jointly considered, the tin should never go below the common solder basis, which is 50-50. In pouring the lining metal, the tinned surface should never be much, if any, below the freezing point of the tinning compound. Throwing or dropping lined bearings with lined surface down on hard surfaces is always calculated to weaken the lining union. In lining a bearing a week after boring it, no surprise is due if trouble is experienced in getting a good tinned surface. The other considerations in this connection are too obvious to require comment. The loose bearing is an extremely serious service proposition and should be guarded against with maximum concern. Often, adhesion is weak or absent only in spots, but this is no mitigating argument. Every bearing should be tapped on the back with a hammer in three or four vicinities and in suspended position and dispatched to service only when the ring is true in each and every instance of tapping.

Smooth Bearing Surfaces

Science explains friction on the over-lapping of molecules. In the smoothest of surfaces in contact this condition prevails. As surfaces roughen, not only molecules, but even masses get a gripping chance at each other and friction with developing heat intensifies. The smooth bearing surface, therefore, is the only one logical. To this end mandrels should never be allowed to rust into uneven surfaces. Nor should they be subject to that abuse resulting in mutilation of these surfaces. Likewise with finished bearings. To nick or gash their lined surfaces by rough handling not only roughens them to greater friction, but also creates those grime-collecting receptacles already referred to. On bearings finished and ready for shipping the writer sometimes feels like stenciling the caution: "Handle With Care".

Suitable molding machines and good molding machine practice should be accorded the bearing back in the making. To minimize the oxide evil in

the journal surface, all bearings should be cast with this surface in the drag half of the mold. Ample precaution should then be taken against cope swelling. In boring the bearing preparatory to lining, a clean fillet should be cut on the one end and a clean, smooth face machined on the other. To buff these ends on an emery wheel and let them go at that admits fine emery embedding in the brass and cutting the collar and fillet of the journal as they wear into the embedded emery. In all phases of manipulative practice precautionary measures against any such condition are important. We recall visiting a railroad foundry once and seeing a man buffing on an emery wheel the lining surfaces of some dozen or more bearings. The bearings were of new and larger type to the boring of which the foundry had not yet equipped its boring mills. Therefore, they were trying to buff a clean tinning surface on the journal side. Of course, no highly satisfactory tinning surface could be guaranteed by the process and what would happen to the journal if forced to meet this emery-polluted surface would scarcely require a gutta-percha imagination to divine.

Details in Practice

Many apparently insignificant yet important items of detail in practice might be further considered. Antimonial lead shrinks perceptibly in cooling. In pouring, the lining metal shrinks considerably below the end surface during this cooling process. This shrinkage, of course, is filled in with an additional supply. If done while the shrinking metal is yet plastic or granular, no parting line results. If delayed until complete solidity occurs in this shrinking mass, an open suture or line of union is nearly always in evidence. The results possible are imperfect union and a grime-accommodating crevice. To avoid tinning of surfaces not so intended, bearings are often painted with a wash of common clay or fire clay and water. To allow journal-engaging surfaces to carry this gritty coating into service is by no means, good, careful practice. By enormity of demand, journal bearings are produced as rapidly perhaps as any class of non-ferrous work doing extensive service today. A rapidly producing system is a good thing if all the little items of detail are accounted for and faithfully controled by the system. Otherwise it is not and regardless of increased capacity, no journal-bearing-producing system is justified if disregarding the many small details so vital to efficient bearing service demanded on railroad cars. By the same consuming demand, railroads find it expedient to take every advantage favoring reduction of journal price. From over-anxiety, principles of false economy are always liable to spring. A good journal bearing is like anything else that is good. It has a healthy equivalent in the coin of the realm.

Evils of Present Policy

The general policy of railroads is to use bearings as they come from the lining mandrels, the finishing process consisting of rough-trimming of the edges and ends. This practice imposes on service serious contentions with a hard surface-skin embodying surface impurities, with inequalities of surface arising from uneven shrinkage, and with a concealed porosity in the lining metal of many accepted bearings. That the situation involves its adverse consequence is a matter not foreign to the intelligence of motive power officials. They recognize the principle and apply it to their engine-truck and trailer brasses where service is similar in many respects to that of the car bearing. However, an engine put out of service is a different proposition from an incapacitated car. This fact, along with the tremendous preponderance of car over engine bearing demand has doubtless influenced motive power officials to deny the one that all along they have accorded the other. The practice, however, has fallen prey to a more sensitive suspicion and the indications are toward a change in method for experimental purpose at at least. The idea of boring a journal bearing after lining it is a sound one and has already been taken up by different roads. Change in conditions has much to do with the necessity for change in practice. The 3¾ and 4¼-inch journals, the 60,000 and 80,000-pound capacity cars and the 20 to 40 miles per hour train speeds belong to a closing era of rail history. In their stead have come greater things with greater achievements still in promise. What answered them in co-ordinating equipment will not answer now nor satisfy the future. Car-bearing service is becoming more and more exacting and will have to be catered to accordingly. In boring after lining the bearing as bored should still remain a crown bearing. This means that we must either add stock to the crown of the lining alone and then bore out the crown only or add stock uniformly and make two separate cuts, the distance of the bearing from the boring bar in the one cut to be greater than that in the other and the cutting tool so manipulated as to realize the double radii of the crown bearing surface. This consideration arises from the physical impossibility of generating more than one circle from a fixed tool revolving from a fixed center.

The second consideration has to do with the place where the linings are bored. If the foundry is a distributing center with the points where the bearings are applied to service far removed from it, then the boring should be done at the division point and not at the foundry. Unnecessary handling of bored bearings is wasteful and dangerous, and for these reasons shipping the machined bearings should be avoided as much as possible.

The Failure of Brass

"The Failure of Brass" is the title of a publication recently issued by the United States Bureau of Standards, which discusses the microstructure and initial stresses in wrought brasses of the type consisting of 60 per cent copper and 40 per cent zinc. Wrought brass bolts were the subject of the initial experimental investigation, in the course of which the physical properties, microstructure and initial stress distribution have been studied. Both failed and sound materials were obtained from the Catskill aqueduct construction, the filtration plant of the city of Minneapolis, the navy department and the Panama canal and new material was secured from a number of manufacturers, totaling 250 specimens. The results indicate that failure has occurred as the result of faulty practice in forging bolt heads, flanging plates, etc., as the result of the presence of initial stress, and as a result of service overstress due to drawing bolts up too tightly. This investigation shows that an average initial stress of 5,000 pounds per square inch is to be regarded as a safe limit for rods and bolts of this type of material under ordinary service conditions in which the service load itself is not greater than from 5,000 to 10,000 pounds per square inch.

Brass Cleaner and Deoxidizer

A new deoxidizer and cleaner for brass castings has been developed by E. D. Frohman, of the S. Obermayer Co., Pittsburgh. The purpose of this purifier is to eliminate the oxides which form in ladles or crucibles when melting non-ferrous metals. The purifier contains phosphorus, which combines with the oxides in the metal and reduces them, freeing the metallic elements. The

phosphorus oxides formed by the reaction come up to the surface of the molten bath in the form of gas or skimmings. Also, it is stated that a small portion of the phosphorus combines with the copper in the mixture. The purifier does not act as a flux, but simply as a reducing agent.

When melting with flame-type furnaces, the purifier is preferably placed in the bottom of the ladle before pouring in the proportions of one pound of cleaner to every 500 pounds of molten metal. The reducing agent also may be mixed with the brass turnings and scrap before charging. For this purpose two pounds of purifier to 500 pounds of metal are required. Where ingot metal is used, the manufacturer recommends the addition in the furnace of one pound of cleaner to 500 pounds of metal. If the metal is melted in crucibles, one-half of this amount of reducing agent should be sufficient.

The manufacturer states that the use of this reducing agent will decrease the oxides in the skimmings from an average of 20 per cent to 0.5 per cent.

The production of copper in Arizona in 1916 is estimated at approximately 675,000,000 pounds, as compared with 432,000,000 pounds in 1915. This exceeds the total output of the United States as late as 1902. Michigan produced 269,000,000 pounds, as compared with 238,900,000 pounds in 1915. The output from Alaska, estimated at 120,000,000 pounds, compared with 70,600,000 pounds in 1915.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Welding Copper

In the squirrel cage rotor on the induction motors which we manufacture we use hard drawn bars in the laminated part and cast the copper end ring onto these projecting bars. However, we are experiencing considerable difficulty as a result of the cracking of the ring and the copper does not fuse rigidly to the copper bars. Have you any suggestions whereby we can overcome this difficulty?

We believe the difficulty outlined has caused some manufacturers to abandon this method of producing this type of rotor. It always will be found troublesome to fuse cast copper rigidly onto hard drawn bars, since the copper chills when it comes in contact with the cold metal. To satisfactorily burn or weld copper onto a cold surface of the same metal, a considerable amount of the molten metal must be blowed-off to heat the cold body of metal to the temperature at which union can occur. However, since this is not practical in this case, we suggest that some other method be devised. We are of the opinion that your difficulty could be overcome in a satisfactory manner with the aid of the oxy-acetylene torch.

Steam Metal Fixtures

What is the best mixture for a good steam metal for globe, angle and radiator valves, in which the metal is more or less thin due to the low pressure?

A good steam metal formula follows: Copper, 86 per cent; tin, 7 per cent; zinc, 4 per cent; lead 3 per cent.

A cheaper alloy for radiator valves follows: Copper, 87.5 per cent; tin, 3.5 per cent; zinc, 7 per cent, and lead, 2 per cent.

Another mixture, not as expensive as the foregoing, follows: Copper, 76 per cent; zinc, 10 per cent; lead, 10 per cent and tin, 4 per cent.

Of the three formulas given, No. 1 is to be preferred.

A Difficult Mixture to Cast

Recently we have been making large bronze plates, 14 x 18 inches in size and 1 inch thick, from a mixture containing copper, 148 pounds; tin, 20.50 pounds; lead, 19.25 pounds and 15 per cent phosphor-copper, 12.50 pounds. The castings are exceedingly porous and since they are designed to withstand a pressure of 2,000 pounds per square inch, are unsatisfactory.

Reduced to percentages, the above mixture figures about as follows: Copper, 79.31 per cent; tin, 10.25 per cent; lead, 9.50 per cent, and phosphorus, 0.94 per cent. This is practically the regular 80-copper, 10-tin and 10-lead alloy plus 1 per cent of phosphorus. It is a difficult mixture to cast and is susceptible to porosity. There is a proper temperature for pouring these high-phosphorus alloys very difficult to describe and if there is no one at hand with the necessary experience to determine this point, we suggest that the molds be made with a dry sand facing, coated with a plumbago wash and afterwards dried. Pour the metal cool and use care in melting. There are some alloys of copper, tin and lead, when the tin content is over 10 per cent, that cannot be cast to make sound castings by any ordinary method and the above alloy minus the phosphorus is one of them. With the phosphorus, sound castings can be obtained, but difficulty may be encountered at any time. The following alloy is recommended: Copper, 85.75 per cent; tin, 10.25 per cent; zinc, 2 per cent; lead, 2 per cent, and 15 per cent phosphorus copper.

Tobin Bronze

We would like to have mixtures for welding rods, such as Tobin bronze, manganese bronze, copper and aluminum.

The formula for Tobin bronze follows: Copper, 59¼ pounds; zinc, 40 pounds and tin, ¾ pounds.

Manganese bronze: Copper, 61.50 per cent; zinc, 36 per cent; iron, 1 per cent; tin, 0.75 per cent; aluminum, 0.25 per cent and manganese-copper, 0.5 per cent.

Copper: Copper, 98.25 per cent; tin, 1.25 per cent, and phosphor copper, 0.5 per cent.

Aluminum: Use pure aluminum.

An Anti-Acid Bronze

We would like to have a mixture for a tough alloy for making castings to be used as hangers on dipping trays that are submerged in a sulphuric acid solution. These castings are about 20 inches long and weigh 20 pounds each. The only acid bronze that we can find a record of contains copper, lead and antimony, but this is not sufficiently tough for our purpose.

We suggest the use of aluminum bronze, an alloy consisting of 92 per cent copper and 8 per cent aluminum being recommended. This mixture is strong and tough and will withstand the action of sulphuric acid as well as any metal that we can suggest.

No. 12 Aluminum

We would like to have you furnish us with the formula for No. 12 aluminum.

The formula for No. 12 aluminum follows: Aluminum, 92 per cent and copper, 8 per cent. This alloy is preferably made by the use of a hardening alloy consisting of 50 per cent copper

and 50 per cent aluminum, 16 parts of which are melted with 84 parts of aluminum at as low a temperature as is consistent with the proper alloying of the metals. When melted, the alloy is fluxed with zinc chloride, after which it is removed from the furnace and poured.

Mixture for Aeroplane Motor Castings

We are engaged in the manufacture of large aeroplane motors and we would like to know the most suitable aluminum alloys for the cylinders, pistons, crank cases, etc., for these machines. Also let us know the composition and characteristics of aluminum alloys which you consider most suitable for these purposes. What should be the shrinkage allowance for patterns on aluminum castings and what are the common troubles experienced by foundries in doing this work?

One of the best aluminum alloys for the purpose outlined consists of aluminum, 93 per cent, and copper, 7 per cent. It is made by melting 86 per cent of aluminum with 14 per cent of a hardener composed of 50 per cent aluminum and 50 per cent copper. The patternmaker's allowance for shrinkage is 0.186 inch per foot. The common trouble experienced by foundries is porosity, which manifests itself in the form of black spots which are really dirt-filled holes. This is guarded against by pouring the metal in the molds at such a temperature which insures free running, but its congelation, almost immediately after it is cast, and the time of its contact with the sand in a liquid state is reduced to the minimum. A heavy aluminum casting poured at a temperature of 850 degrees Cent. will be porous, but when cast at 680 to 700 degrees Cent., such a casting will be sound. Therefore, do not pour the metal too hot.

Shrinkage Difficulties

We manufacture railway bearings, but when fractured they develop reddish brown discolorations and we have been unable to discover the cause of this difficulty.

An examination of the fractured surface of the sample casting submitted indicates the difficulty to be due to the shrinkage of the metal. The casting is of heavy section and has a reddish area in the center of the fracture, the ground mass being gray, uniformly interspersed with minute reddish spots. The absence of the gray constituent in the center is the cause of the reddish appearance of the fractured surface at this point, which manifests itself as a porous mass when the surface is machined. The remedy is to use feeders sufficiently large to keep the center filled with the lower melting gray constituent of the alloy, which in this case is rich in lead. The problem is one of properly feeding the casting and if this is not possible, chills should be resorted to. It long has been recognized that manganese bronze requires large risers to insure sound castings, but it is less generally known that ordinary copper-tin, copper-tin-lead and copper-tin-zinc alloys shrink just as badly, because manganese bronze shows shrinkage by a depression or a cavity. In conjunction with feeding by the use of risers, it is advisable to employ a suitable flux when melting the metal.

Mixing and Melting Yellow Brass

We would like to have several mixtures for yellow brass with instructions for melting this alloy.

A good casting alloy for general purposes follows: Copper, 75 per cent; zinc, 21 per cent; lead, 2 per cent, and tin, 2 per cent.

Naval brass.—Copper, 62 per cent; zinc, 37 per cent; tin, 1 per cent, and lead, 1 per cent.

A cheap casting mixture.—Copper, 67 per cent; zinc, 30 per cent; lead, 2 per cent, and tin, 1 per cent.

Casting brass.—Copper, 65 per cent; zinc, 32 per cent; iron, 1 per cent, and lead, 2 per cent.

Muntz metal.—Copper, 59.5 per cent; zinc, 40 per cent, and tin, 0.5 per cent.

These alloys are not difficult to make and the copper first should be melted under a cover of granular charcoal together with a small amount of salt. Have the zinc broken into small pieces and place it on the furnace top to heat while the copper is melting. When the latter is thoroughly liquid, add the zinc, one piece at a time, and stir well to thoroughly incorporate each piece before introducing more cold metal. When the zinc has been charged, follow with the lead and tin. Pour the metal strongly into the molds, keeping the heads filled, and pour hot rather than cool.

Rolling Mill Bearings

We would like to have mixtures for rolling mill bearings, as well as advice regarding melting.

Use the following mixture: Copper, 80.5 per cent; 30 per cent phosphor-copper, 1 per cent; tin, 11 per cent, and lead, 7.5 per cent. Melt the copper under charcoal, add the phosphor-copper, followed by the tin and the lead. Stir thoroughly and pour at a medium temperature.

Sizes of Stack and Flues for Melting Furnaces

We are planning the erection of a battery of six brass melting furnaces. We do not obtain a sufficient number of heats from our present equipment and we want to be sure that the new furnaces will give us better results. In your judgment, what should be the height of the stack? Also, what should be the inside diameter of the stack and the inside measurements of the flue box?

To make an intelligent reply to your inquiry it is necessary to know the height and diameter of the stack of the present furnaces, also the sizes of the main flue and the connecting flues from each furnace. The number of heats taken from each furnace should be stated and the number to be expected also should be given. In general, the height of the stack is comparatively unimportant as long as it extends above the buildings in the immediate vicinity. The dimensions of the stack inside, the main flue and connecting flues are the more important factors to be considered to obtain efficiency in melting. For six furnaces make the connecting flues 6 x 4 inches, the main flue 18 x 12 inches and the stack 24 x 18 inches and 40 feet high, or as much higher as may be necessary to carry it above the surrounding buildings.

Overcoming Porosity

We manufacture brass standards for steering wheels for large steamships. The standards are machined and we are having considerable trouble from porosity. We realize that this can be overcome by adding copper, buf this will increase the cost of the mixture to a prohibitive figure. Can you suggest a cheap mixture of yellow brass that will work satisfactorily and finish nicely?

The following alloy will be satisfactory for the purpose suggested: Copper, 60 pounds; zinc, 40 pounds; tin, 0.5 pound; lead, 1 pound; manganese-copper, 0.25 pound and aluminum, 0.25 pound. This makes a total of 102 pounds for the mixture. The additional 2 pounds is to allow for zinc volatilization, so that the analysis will show between 39 and 40 per cent of this metal. This alloy will run well and will produce satisfactory castings if the proper precautions are exercised. It is a mistake to imagine that porosity can be overcome by the addition of copper, since the latter metal is not a deoxidizer and the porosity is due to the oxidation of the metal during the melting process. The remedy is better melting practice with the use of plenty of fine charcoal as a cover for the metal and the employment of a small amount of common salt as a flux.

How to Buy Pattern Lumber Economically

Pattern Lumber Specialists Understand Foundrymen's Needs—Buy the Most Economical Grade for Your Work—Study Local Conditions

By H Cole Estep

MURPHY, the pattern shop foreman, reported that his supply of lumber was about exhausted. So Brown, the manager of the plant, diverted a fragment of his attention from the weighty problems of the Saturday payroll long enough to settle the annoying detail that had been brought to his attention. He turned to his clerk and issued the following order:

"Call up the Polson Lumber Co. and tell them to send us a thousand feet of their best A-1 pattern lumber."

And straightway Brown forgot about pattern lumber. It is to the credit of the Polson Lumber Co., however, that it delivered the goods according to specifications. The Polsons were retail lumber dealers, and they kept, or tried to keep, a stock of all kinds of lumber for all sorts of purposes from dog houses to fine patterns and even furniture. They ransacked their stock and sent Brown "their best pattern lumber"—the best they had. The designation "A-1" meant nothing definite either to the lumber dealers or to Brown, the foundryman

So Brown got all he bargained for, including a bill for $90.30. It was not the lumber company's fault that he did not, as a matter of fact, obtain the best, or the most economical lumber for his purpose. The lumber dealers did 90 per cent of their business with local building contractors and they could hardly be expected to be familiar with the peculiar requirements of the foundry business or the patternmaker's art. Nor was it their fault that the tremendous inroads on the supply of standing timber in the last two decades has made it virtually impossible for anyone but a specialist to secure certain fancy grades of lumber. The Polson Lumber Co. took what it could get through the ordinary channels of the trade and worked as much for price as for quality. One result was that Brown was paying out more than the cost of his lumber every month in unnecessary labor in his pattern shop.

How the Specialist Can Help

Brown's situation was not unique. Hundreds of foundrymen all over the country cling to the time-honored custom of buying their pattern lumber from local dealers. Acting on the advice of their pattern shop foremen, they almost invariably specify "the best" without knowing what it is, and as a result they pay high prices and obtain, not the best, but merely the best the dealer happens to have on hand. These foundrymen have not yet learned that specialization counts in the pattern-lumber business as in other departments of the foundry industry.

Scarcity of Fine Lumber

In fact, as already suggested, the condition of the lumber market today is such that specialists have a great advantage in obtaining uniform grades of lumber suitable for patterns. The prodigal waste of the timber resources of America is proverbial. We have destroyed and burned our forests, until now we are in sight of the day when we shall have to go without. Among the ordinary woods, absolutely clear, straight, sound, flawless planks of fair size, say 1 x 10 inches x 16 feet, are a rare commodity. A prominent pattern-lumber dealer stated recently that he was six months picking out a carload of super-high-grade lumber of this character for a special purpose. Yet this is what many pattern shop foremen think they must have. As a matter of fact it is next to impossible to get it, and slightly lower grades of material, from a lumberman's standpoint, are in every way suitable. To put it another way, clear planks are to the lumberman what tool steel is to the metallurgist—fancy stuff—and no foundryman, under ordinary circumstances, would think of buying tool steel scrap for his cupola charges.

The conditions we have attempted to sketch in the foregoing paragraphs have created the pattern-lumber specialist, and it is to him that the progressive foundryman is turning to solve his pattern-shop raw-material problems. There are several large companies specializing on pattern lumber in the United States and their success testifies to the soundness of their position in the economic order. These organizations combine a knowledge of the requirements of the foundry and patternmaking industries with expert information on the lumber trade. Their resources are such that they are able to control certain high grades of lumber, suitable for patterns, from the time the tree is cut until the air-seasoned plank is delivered to the pattern shop racks. Such concerns are in touch with sources of lumber supply that ordinary local dealers cannot profitably reach.

Several pattern lumber specialists own their own standing timber, which has been carefully cruised and selected for the purpose intended. These concerns also frequently have sawing contracts with mills, which puts the mill in the position of a hired servant rather than that of a seller. All of these arrangements tend toward the conservation of the comparatively limited supply of high-grade pattern woods, for the benefit of the foundry industry.

The foundryman who expects to buy his pattern lumber economically must ask himself two questions. *First:* What is the best kind of lumber for me, considering the location of my shop and the sort of patterns I expect to make? *Second:* What is the most economical grade, considering pattern-shop wages, the time required to make the patterns I have in mind, and the waste in cheap lumber?

A Simple Lesson in Economics

Considering the first question, we find that in the northern, northeastern and middle western sections of the country white pine is one of the most widely used pattern woods. The reasons for this are obvious to every foundryman. Yet there are occasions when other, more durable woods should be substituted for pine. A certain Michigan gasoline engine factory made a pine pattern of a crank case for a new type of engine. The production had not reached the stage where a metal pattern would pay. But experience with the pine pattern soon showed that something representing an intermediate step between soft wood and metal was needed, for the pine pattern had to be returned to the shop for extensive repairs after it had been used for making 65 molds. After it was repaired, 65 more molds were made, when it was so dilapidated that it had to be replaced. In making the new pattern, mahogany was tried. Before the mahogany pattern had to be returned to the shop for

attention it turned out 140 molds. After slight alterations it went through another run of 238 molds. The pine lumber cost about $100 per thousand board-feet and the mahogany $180. Yet it was cheaper in the end. On the other hand, had only 40 or 50 molds been desired, or perhaps a lesser number, pine would have been much preferable, not only on account of its lower first cost, but because it is more easily worked and cuts down the pattern-shop labor.

In brief, the selection of the proper kind of pattern lumber is purely a question of dollars and cents that a foundryman should be able to work out from his pattern-shop records. The same applies to the grade of lumber employed. It is a pattern-shop axiom that the cost of the pattern is in the labor required to make it. This is not literally true at present, owing to the extremely high price of the very best grades of lumber. The cost of the raw material in these days is an item to be reckoned with as well as labor costs in pattern construction. Occasionally money can be saved by using lumber of a grade somewhat lower than the proverbial best.

An Endless Labyrinth

When the foundryman gets into this question of lumber grading, however, he frequently finds himself in an endless labyrinth. In the first place the various lumber manufacturers' associations have separate grading schedules pertaining to their particular products. Secondly, lumber usually is graded by inspectors who represent the producers rather than the consumers. In many cases, the so-called independent inspectors, although not in the employ of any individual manufacturer, represent the lumber industry as a whole. Finally, in spite of the honesty of the grading—and practically all of it is fair and square—there is a prolific source of dispute and misunderstanding in the fact that after all it is largely a matter of opinion. The grader looks at a plank and classifies according to his judgment of its appearance. Lumber cannot be graded on the basis of definite, measureable constituents like pig iron.

Large concerns meet this situation by employing experts to inspect their purchases and make it certain that the specifications are being lived up to. Obviously, the ordinary foundryman cannot go to this expense to inspect three or four carloads of pattern lumber a year. His most satisfactory course of action lies in picking out a reliable specialist in pattern lumber whom he can take into his confidence and on whose judgment of lumber values from a pattern-shop standpoint he can rely. If he will follow this policy, and will back it up with suitable, simple patternshop records that will tell in black and white what really is the most economical lumber for certain classes of patterns, all factors considered, he will have made a long step forward in the solution of his pattern lumber problems.

Different Kinds of Pattern Lumber

Now a word about the physical characteristics of the various common pattern woods. Pine and mahogany already have been mentioned. In the same general class with pine are the spruces, hemlock, redwood, certain varieties of cedar, etc. Of the evergreen woods, however, northern white pine, sometimes called cork pine or sugar pine, appears to be the king of soft woods for pattern construction. It can be worked easily to a smooth surface; it does not split readily; it is easy to pare and does not dull tools as fast as some other varieties of lumber. It also has a sufficiently fine grain to take a high polish with shellac varnishes. When properly dried and varnished, it exhibits remarkable resistance to the warping and swelling action of damp molding sand. Spruce, redwood, Port Oxford cedar, etc., are used in the Rocky mountain and Pacific coast districts. They are not as uniform and readily worked as northern white pine.

Poplar, or white wood, is frequently used for making patterns. It has a fine texture and a satin luster. It shrinks moderately and can be given a fine finish with shellac. Some grades warp more readily than pine, but it is a dry wood that does not absorb moisture readily. In this connection, it might be pointed out that trees growing on high ground, on account of their dense texture and comparative freedom from moisture, are usually preferred for pattern lumber to those growing in wet, swampy localities.

Among the hardwoods, mahogany and cherry appear to be the most popular. They are both dense, straight-grained wood of uniform texture. They are impervious to moisture and take an unusually fine polish. Also they resist wear in a satisfactory manner and, as previously pointed out, make more durable patterns than the soft woods. On the other hand, they are more expensive than pine or its associated soft woods and are harder to work, increasing the labor cost on given patterns. So in the last analysis, the selection of pattern wood is purely a question of dollars and cents, based on the use to which the pattern is to be put. The same kind of lumber cannot economically be used for all purposes.

Similar principles apply in the selection of flask lumber, except that in this case local lumber-market conditions form the governing factor. The life of the ordinary wooden flask is so short, due to burning and general abuse, that only the cheapest sort of lumber is economical. This, of course, does not apply to small, highly-finished, metal-bound snap flasks, but to common flasks used in floor molding. Under ordinary circumstances it does not pay to ship flask lumber any great distance. Therefore, in the northwest we find that fir is a favorite; in California it is redwood or cedar; in the middle west, spruce, Norway pine, yellow pine or low grades of white pine are employed. For similar reasons foundrymen in Borneo may use teak for flasks, while their fellow craftsman in southern Ohio buy wormy chestnut.

Lenoir Car Works Installs Open Hearth

David McLain, Goldsmith building, Milwaukee, has completed negotiations for the installation of a 2-3-ton open-hearth furnace in the plant of the Lenoir Car Works, Lenoir City, Tenn. This furnace is guaranteed to melt five 2-ton or two 2-ton and two 3-ton heats in 12 hours, and the temperature of the metal will be such that the smallest castings made in the average crucible steel foundry may be poured successfully. This is the fourth furnace of this type for which David McLain has received contracts in less than a year.

Limestone for Cupola Flux

By W. J. Keep

Question:—We would like to have the analysis of a good limestone to be used as a cupola flux. What is the permissible maximum content of magnesium carbonate, silicon, phosphorus, iron, aluminum and sulphur and what is the permissible minimum content of calcium carbonate? In other words, would the presence of 10 per cent magnesium carbonate, 0.40 per cent silicon or 0.004 per cent phosphorus be objectionable?

Answer:—It is difficult to obtain a limestone containing less than 10 per cent magnesium carbonate. If it were all lime it would be preferable. It is quite common to have stone containing 40 per cent of magnesia, when it becomes a dolomite and is of no use for cupola fluxing purposes. Such a small percentage of silicon will do

no harm and the phosphorus content will prove beneficial rather than detrimental. The carbonate of lime should be 86 per cent. The danger is in the content of iron pyrites, which appear in dark patches and in this form it all enters the iron. The following analyses were made of samples of western Lake Erie limestone and the iron contained in the sample from Sibley, Mich., namely 2 per cent, might spoil a heat:

Analysis of limestone from Marblehead, O.—Calcium carbonate, 83.20 per cent; magnesium carbonate, 15.83 per cent; silica, 0.15 per cent; organic matter, 0.02 per cent, and moisture, 0.80 per cent.

Kelley Island limestone.—Calcium carbonate, 87.50 per cent; magnesium carbonate, 9.75 per cent; silica, 1.81 per cent; alumina, 0.75 per cent; phosphorus, 0.01 per cent, and magnesia by difference, 0.17 per cent.

Sibley, Mich., limestone.—Calcium carbonate, 98.48 per cent; magnesium carbonate, 0.15 per cent; silica, 0.17 per cent, and moisture, 1.20 per cent.

Another limestone sample from Sibley, Mich.—Calcium carbonate, 86 per cent; magnesium carbonate, 9 per cent; silica, 3 per cent, and iron, 2 per cent.

Charles J. Stark Appointed Editor of The Iron Trade Review

Charles J. Stark, associate editor of *The Iron Trade Review*, located at the New York office of the Penton Publishing Co., has been appointed editor of this publication to fill the position formerly occupied by George Smart, resigned. Mr. Stark has been connected with the editorial staff of *The Iron Trade Review* for more than a decade and he brings to his new position the fruits of mature study of the iron and steel industry of the United States, as well as the broad viewpoint resulting from a wide acquaintance among both producers and consumers of iron, steel and machinery products. He joined the staff of *The Iron Trade Review* as associate editor at Cleveland, in 1907, and the following year he became Pittsburgh representative. In February, 1910, he was transferred to New York and since that time has had charge of the metropolitan office of the Penton Publishing Co., publisher of *The Foundry*, *The Iron Trade Review* and *The Daily Iron Trade and Metal Market Report*. Mr. Stark will assume his new duties about April 1.

To fill the vacancy created by the promotion of Mr. Stark, Edgar C. Kreutzberg has been appointed associate editor in charge of the New York office. He also will continue to serve as associate editor of *The Foundry* and of *The Daily Iron Trade and Metal Market Report*. Mr. Kreutzberg has been in the New York office of the Penton Publishing Co. for four years and is thoroughly familiar with the eastern field.

Mr. Kreutzberg's former position in the New York office will be filled by Guy F. Creveling, who has been connected with the Penton Publishing Co. in an editorial capacity since October, 1912.

How to Eliminate Sulphur Holes in Castings

By Edgar Allen Custer Jr.

The concensus of opinion among foundrymen, and, in fact, among all those who are in any way connected with the casting of iron, seems to be that as a maker of scrap and a profit reducer, sulphur stands in a class by itself. It is undoubtedly true that it receives more attention and is watched far closer than any of the other elements that control the grade of iron, and poor mixtures and resultant scrap piles are frequently said to be due to the pernicious influence of this element. We are all, more or less, familiar with the general overhauling that follows its appearance in excess, in which everyone, from the chemist to the laborer on the charging floor (not omitting the coke salesman), comes in for his share, yet the tendency in every case seems to be directed toward the keeping the sulphur as low as possible rather than to correct, insofar as it is possible, its evil tendencies in the casting.

The results of sulphur in excess are threefold. It causes a reduction in tensile strength; it increases the shrinkage; and results in the appearance of numerous gas holes familiarly known as sulphur holes. It is the last of these factors that causes the most serious loss to foundrymen, since the first two are not necessarily fatal to the casting. The deterioration in the physical qualities in a great many instances is not sufficiently great to preclude the use of the casting, and the excessive shrinkage may be overcome by the intelligent use of risers and feeders.

Gas Holes a Bugbear

The question of gas holes, however, is one that no foundryman can afford to overlook, since nothing will injure a foundry's reputation so much as tales of hours of machining and labor lost when the machinist's tool opens up a series of these sulphur holes.

A particularly erratic car of coke, together with a series of errors of commission and ommission in a certain foundry not long ago caused more than usual interest to be taken in the sulphur question, and a series of experiments were undertaken in an effort to dodge the overdose of sulphur. Omitting mention of the numerous changes in cupola mixtures and the various forms of cupola operation, sane and otherwise, that were tried out, the direct result of the investigation was as follows:

It was first observed that regardless of the chemical composition of the iron, whether it be high or low in any or all of its elements, when in a molten state it is a homogeneous mass. The carbon is all combined carbon, and the sulphur, manganese, etc., are in chemical composition with the iron. Assuming that this theory is correct, it is evident that segregation must occur after cooling has started. This is most effectively proved by the fact that the ratio of combined carbon and free of graphitic carbon is determined almost entirely by the rate of cooling. The more rapid the cooling, the greater the amount of combined carbon.

It was next observed that when special mixtures are formed containing sulphur decidedly in excess, the resultant castings invariably contain a large number of sulphur holes, yet when the same mixture is drawn off into a ladle and allowed to solidify, it is found to be free from these holes. This gave rise to the natural theory that the formation of these holes is a result of the process of casting and not a result of ordinary segregation.

Lessons from Holes

From the very nature of these holes it is apparent that sulphur must be combined with some other element to produce a gas, since the affinity of sulphur to the iron or to the other elements is too great to allow it to exist in a free form. It also was argued that when sulphur is segregating, it must be doing so under the influence of some element for which it has a greater affinity than it has for any of the elements contained in the mixture. The question of a possible combination with other elements in the mixture was dropped because these gas formations, while existing in the casting, did not exist in the open ladle even though the analysis proved these mixtures identical. If this be so, it at once becomes apparent that the formation of sulphur holes must result from the introduction of some other element after the metal has left the ladle and entered the mold. The possibility of gas forming combinations resulting from the action of the hot iron on the sand of the mold, rendering gaseous any of the elements contained in the sand or binder, was obviated by the use of an iron mold, in which the test

castings were cast. The first two or three pours served to burn off all foreign matter adhering to the mold leaving the matrix practically naked iron. It was found, however, that the same mixture of high sulphur iron develops gas holes in direct ratio to the velocity of pouring, making it seem that the method of introducing the iron into the mold is directly responsible for the formation of the gas holes.

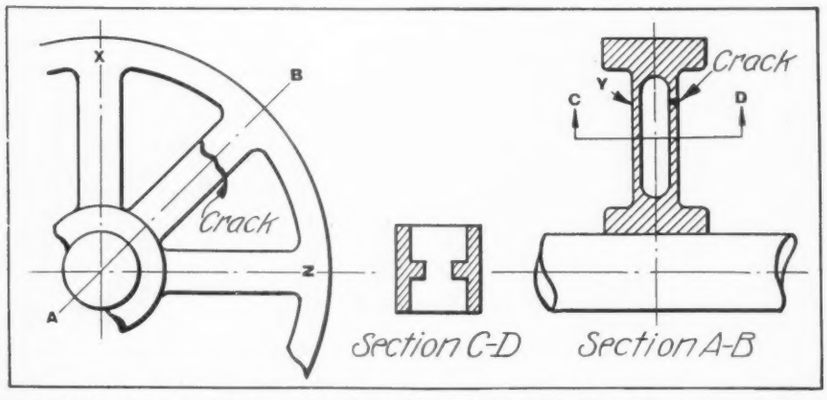
Since by successive steps it was proved that the formation of the gas holes results from the union with some element not contained in the mixture, and that this union takes place between leaving the ladle and filling the mold, there is but one theory left, and that is that the iron was trapping air and carrying it with it into the mold. It was reasoned, and later proved correct, that the iron, as it flows into the gate, carried air with it in precisely the same manner that a stream of water carries air with it as it runs into a glass of water. The size and number of the sulphur holes decreased or increased according to the speed of the iron in the gate. If poured slowly, the buoyancy of the air was sufficient to cause it to rise against the flow of the iron and escape through the gate, but as the speed of the iron was increased, it overcame this buoyancy and carried the air with it into the mold. This air, or rather its oxygen content highly heated by contact with the hot iron, will unite with practically every element with which it comes into contact, according to the relative affinity of the oxygen for the elements.

A Novel Theory

Of the elements contained in cast iron, at pouring temperature, oxygen has probably the greatest affinity for sulphur, uniting to form sulphur dioxide, which, when the small particles unite, forms the troublesome gas holes. This theory was further strengthened by noticing the odor accompanying the pouring. When the iron runs from the cupola into the ladle it necessarily must carry air with it, but as the surface of the iron in the ladle is free, the air, and the gas that is formed by the union of the oxygen and the sulphur, are free to escape, the gas being detected by the strong pungent odor of sulphur dioxide. After the ladle has been removed from the cupola and the ebullition has ceased, no odor is noticeable, yet when the metal is again poured into the mold the gas is again noticed, and is more or less noticeable according to the rate of pouring. This would indicate that the quantity of gas formed depends upon the amount of air trapped by the iron.

It remained, therefore, only to prove the theory by applying the remedy. The latter was applied in several ways, all of which depended on the principle of checking the flow of iron in the gate behind a trap, and allowing the air to release itself before entering the mold. The most efficient gate for this purpose seemed to be the type often used in brass and bronze molding to catch dross. The iron flows into a spherical or cylindrical cavity tangentially, setting up a swirl within the cavity. The discharge is in the center of the base of this cavity and leads down and across into the mold. The iron flows into this cavity and by swirling around allows the air and gas to escape through the top of the cylinder, which is open, while the iron, still high in sulphur, but free from gas holes, flows into the mold.

With this type of gate it was found entirely practicable to produce castings absolutely free from gas holes, yet the analysis often showed a sulphur content over 2 per cent. Of course, the resultant castings could hardly be considered serviceable with such a high sulphur content, because the physical qualitities were too greatly impaired.



SECTIONS OF A BROKEN ROTOR CASTING REPAIRED BY THE ARC WELDING PROCESS

Repairing a Large Casting by Electric Arc Welding

By H. A. Baltes

RECLAIMING gray iron castings by electric arc welding has been a much disputed subject. The successes attained by some firms is counterbalanced by the failures of others, who have been unable to make satisfactory welds or repairs. In no sense is this due to the type of equipment employed, this being entirely dependent upon the operator doing the work. When undertaking repairs by this process, the relative expansion and contraction of the casting or part to be welded must be thoroughly studied to prevent the cracking of the weld or adjacent parts of the original casting, while the latter is returning to its normal condition.

Soft cast iron welds cannot be obtained without properly preheating the parts to be welded. Welding a small defect in a large body of cast iron without preheating the casting causes the iron to chill rapidly. The parts immediately surrounding the weld, being cold, will produce a spot of chilled iron in the weld, which the best grades of high-speed tool steel will not cut. This may be eliminated readily by properly preheating the parts to be welded.

It is generally understood that the carbon in cast iron has the power to distribute itself uniformly, not only through one piece, but through several pieces in contact. When a high percentage of carbon is present the formation of graphite is favored. It is believed that cast iron containing a high percentage of carbon, liberates this element when heated and distributes it through the parts being welded, as well as the parts immediately adjoining the weld, thus imparting to the spot that is being welded an unusually high percentage of graphite and making the weld soft and readily machinable.

A concrete illustration of the results that may be attained by arc welding is the repair of a gray iron rotor casting weighing 16,000 pounds, which was reclaimed at one-twentieth of the original cost and at a saving of months of delay in securing a new casting.

The rotor was shipped from England to a firm in Canada and was to be pressed onto the shaft of a Canadian-built air compressor. The arms of this rotor, as shown in the accompanying illustration, were cast with a hollow center, and as indicated by the arrow, only one member of the arm was broken. It was imperative to have the compressor working within

a specified time, so that it was practically out of the question to obtain a new rotor from the manufacturer in England. Our welding expert was consulted and he was convinced that the rotor could be repaired satisfactorily. Before beginning work, the problem of expansion and contraction was considered carefully, since this was the most important factor to determine. We decided that the casting had to be preheated at that point where the adjacent arms joined the rim of the rotor and also that member of the arm which was not broken. The points at which torches were applied are designated at *X*, *Y* and *Z*, in the accompanying illustration. As previously stated, the success of a welding operation of this kind depends largely upon the skill of the operator and his ability to determine the relative expansion and contraction.

Time of Welding

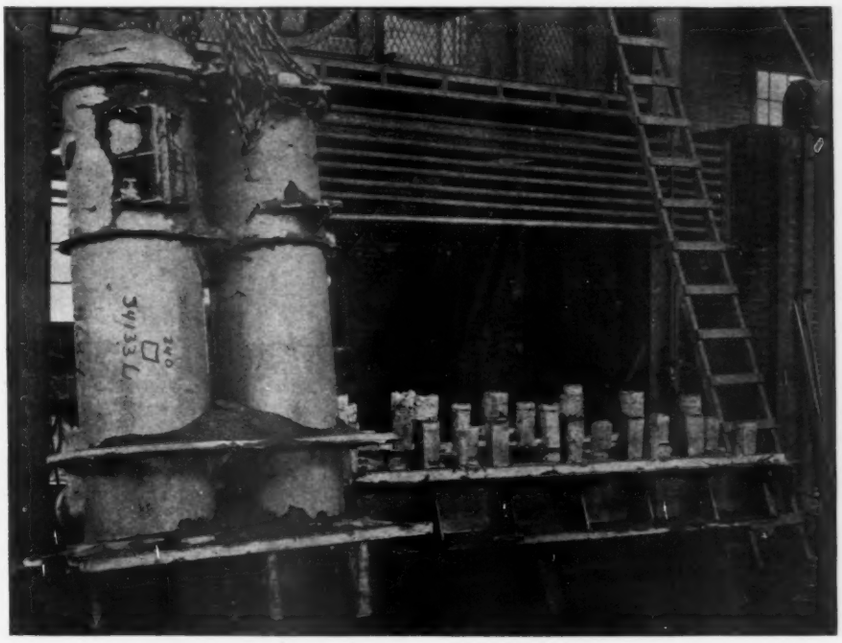
The time of welding, which included preheating, was approximately eight hours and was accomplished as follows: First, the windings were removed about half way around the rotor and the crack was cut out in a V-shaped groove. A dam was built around the arm with carbon blocks, cement having been used to bind them and to prevent the fluid metal from running through the joints. The cement was made of powdered carbon and sodium silicate. Charcoal fires, retained by fire brick, were built at points *X*, *Y* and *Z*, as shown in the accompanying illustration. The member to be welded was insulated from the heat applied to the unbroken member of the broken arm by fire brick held in place by a steel band, ½ inch thick. When the casting was heated to a cherry red at the points where the fire was applied, the welding operation was performed.

After heating the walls of the groove to a plastic state with the arc, the groove was filled with a good grade of high silicon iron. The fires were removed and the casting was allowed to cool slowly, that all parts might assume a normal condition. The customer was of the opinion that the rotor would be thrown out of alignment and that the diameter would be reduced at the point directly opposite the welded arm; however, instead of being smaller at that point, it was found to be ⅛ inch larger. This was remedied by grinding the rotor down to its original diameter. Otherwise the alignment was perfect.

After the casting had cooled, the windings were replaced in their respective slots, the rotor was returned to position and the machine was put in operation.

Vanadium Bronze Submarine Castings

The requirements of the United States government and the entente allies for submarine equipment during the past two years have created a heavy demand for special bronze castings suited to vessels of this character. Vanadium-bronze has been found to fulfill the exacting conditions of this work satisfactorily, and this alloy is now extensively employed in the manufacture of Deisel engines, torpedo tubes, etc. The accompanying illustration shows two vanadium-bronze castings for American submarines under contract by the Electric Boat Co. Two torpedo tube castings are shown at the left, together with a Deisel engine bed-plate at the right.



VANADIUM-BRONZE CASTINGS FOR DEISEL ENGINE BED AND SUBMARINE TORPEDO TUBES, WITH GATES AND RISERS ATTACHED

To insure sound metal, the latter is provided with 18 risers. Each riser is about 2½ inches square and 7 inches high. This casting weighs 4,000 pounds. The torpedo tubes are cast on end as they appear in the illustration. The walls of the rough castings are ¾ inch thick, and in order to remove all traces of surface imperfections they are turned to ⅜ inch in the machine shop.

The vanadium-bronze from which these castings are made contains 60 per cent copper and about 40 per cent zinc. Only a small quantity of vanadium is employed. The metal is melted in a reverberatory furnace, which is considered satisfactory for high-zinc alloys of this character.

The production of chromic iron ore in 1916, it is estimated, will exceed 35,000 tons, as compared with 1,000 tons in 1914 and 3,281 tons in 1915. This tremendous increase in domestic production has been made in spite of largely increased imports. Cromite is an efficient refractory material for lining furnaces and for making chrome brick and steel alloys, the demand for which has largely increased.

"Movies" of Molding Operations

George L. Grimes, Midland Machine Co., Detroit, manufacturer of molding machines, told members of the Pittsburgh Foundrymen's Association how intricate automobile castings are made, at the regular monthly meeting of the society, held Feb. 19, at the Fort Pitt hotel. A number of lantern slides, showing various types of molding machines, were presented and motion pictures were introduced to show how some of the larger foundries in the Detroit district make castings for the automobile industry. One of the films, produced in the foundry of the Packard Motor Co., Detroit, showed the molding of an engine cylinder, the coring of the molds, the gaging of the cores and work on the pouring floor. Another film showed the molding, closing and pouring of an automobile transmission case, and the molding of an automobile exhaust manifold.

The production of spelter from domestic ore in 1916 is estimated at 553,000 short tons, worth at the average St. Louis price about $150,000,000, and from foreign ore at 105,000 tons, a total of 658,000 tons.

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Contents

MAKING GRAY IRON ART WORK 85
ESSENTIAL FACTORS IN FOUNDRY COST ACCOUNTING 90
CUPOLA CHARGING 93
BOOK REVIEW 93
USE OF FLOOD LIGHTS IN INDUSTRIES 94
THE SEASONING OF CASTINGS 96
SLOW MELTING AND BRIDGING 97
MAKING LARGE PURE ALUMINUM CASTINGS 98
ANNUAL MEETING OF TESTING SOCIETY 98
MOLDING WHEELS AND SHEAVES WITH STEEL SPOKES 99
FIGURING THE COST OF THE CUPOLA HEAT 102
BELT SLINGS FOR CORES 102
PROTECTIVE COATINGS: LACQUERS—I 103
FOUNDRY EQUIPMENT CO. EXTENDS PLANT 105
WESTINGHOUSE COMPANY WILL BUILD 105
HOW HEAVY AMMONIA STILLS ARE MOLDED 107
WHAT FOUNDRYMEN CAN DO TO PREVENT HOT BOXES 111
THE FAILURE OF BRASS 114
BRASS CLEANER AND DEOXIDIZER 114
PROBLEM OF THE BRASS FOUNDRY 115
WELDING COPPER 115
STEAM METAL FIXTURES 115
A DIFFICULT MIXTURE TO CAST 115
TOBIN BRONZE 115
ANTI-ACID BRONZE 115
NO. 12 ALUMINUM 115
MIXTURE FOR AEROPLANE MOTOR CASTINGS 116
SHRINKAGE DIFFICULTIES 116
MIXING AND MELTING YELLOW BRASS 116
ROLLING MILL BEARINGS 116
SIZE OF STACK AND FLUES FOR MELTING FURNACES 116
OVERCOMING POROSITY 116
HOW TO BUY PATTERN LUMBER ECONOMICALLY 117
LENIOR CAR WORKS INSTALLS OPEN HEARTH 118
LIMESTONE FOR CUPOLA FLUX 118
CHARLES J. STARK APPOINTED EDITOR OF THE IRON TRADE REVIEW 119
HOW TO ELIMINATE SULPHUR HOLES IN CASTINGS 119
REPAIRING A LARGE CASTING BY ELECTRIC ARC WELDING 120
CONTENTS 122
ARE YOU DOING YOUR SHARE? 122
NEW EQUIPMENT FOR THE FOUNDRY AND PATTERN SHOP 123
WHAT THE FOUNDRIES ARE DOING 126

Are You Doing Your Share?

NOT long ago the editor of a well known trade journal offered to prepare an illustrated article describing certain interesting features of operation in a modern casting plant. In reply to the editor's communication, the proprietor of the foundry expressed his refusal to co-operate in the following words:

If, as you say, we have devised novel methods in our foundry, it has been with the intention of either improving our product or decreasing our cost. To do this has required brains, energy and money, an investment from which we hope to derive returns. We don't wish to appear selfish, but having made this investment, we hardly care to turn it over to competitors, as would be the case if we permitted the publication of the details of our process. That being the case, you can readily appreciate that we would not care for the write-up which you suggest.

Fortunately the number of business men who hold the view expressed by this foundryman is comparatively limited, and is decreasing every day. However, it is this group which is retarding progress and in justice to the casting industry, we propose to show why the close-fisted policy expressed is contrary to the principles of sound business.

In the first place, the foundryman quoted is wrong in believing that the methods employed in his plant constitute secrets which he should guard. Were any process in his establishment possessed of sufficient merit to make it of unusual value to his competitors, he would be powerless to prevent them from learning every detail if they chose to investigate. As a matter of fact, the methods employed in his foundry are well known to scores of tradesmen. Moreover, this foundryman makes the serious mistake of inferring that the alleged "secrets" of his business are the children of *his* brain and *his* money. Either he is honestly deceived in this belief, or he is deliberately claiming credit to which he is not entitled, because he has incorporated in the design and organization of his plant the ideas of hundreds of men. Unwittingly, perhaps, he has forgotten that Bessemer, Reamur, Turner, Bell, Boydon, West, Moldenke, Keep, and others have paved the way for his success. We wonder how he would have fared, had these men refused to divulge the priceless knowledge which their experience provided. This foundryman is a subscriber to several trade journals, and undoubtedly he reads in them the articles contributed by foundrymen whose vision is not as restricted as his. It is even possible that his competitors, from whom he is so carefully guarding his secrets, are silently contributing their share of experience to the industry through the pages of a trade paper. His attitude to them is eminently unfair.

Therefore, manufacturers whose first impulse is to hold tightly to the fruits of their experience, should consider the policy of publicity from an unselfish viewpoint.

New Equipment for the Foundry and Pattern Shop

Manufactures Molding Frame and Flask for Mechanically Drawing Pattern—Develops Enclosed Sand Blast Barrel for Large Castings

ANY mechanical device that draws the pattern greatly simplifies molding operations and eliminates a large part of the skill involved in this essential feature of foundry work. Combining mechanical pattern-drawing with mechanical ramming removes the skill of hand labor, increases production and insures a product that is true to pattern.

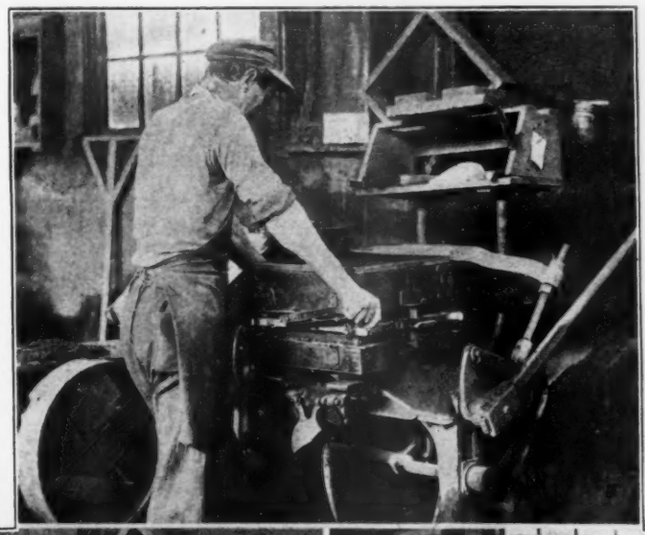
An ingenious molding frame and flask which draws the pattern mechanically and is adapted for use on any style molding machine or on the bench, is being manufactured by the New Foundry Appliance Co., Hamilton, O. To reduce its weight and to facilitate handling, the frame is made of aluminum and all attachments are malleable cast iron. The frame is lined with brass to permit of easily soldering metal patterns and gates to it. The frame is interposed between the drag and cope flask or between a sand or plaster match and the flask, and either the cope and drag can be made in one operation or the drag can be rammed first, followed by the cope. By the operation of a lever the cope is lifted and the pattern is drawn mechanically, after which the mold is lifted off.

In the accompanying illustrations, Fig. 1 shows the operator turning the lever, thereby raising the cope and drawing the pattern. In Fig. 2 the cope has been lifted off and the operator is removing the frame, which is clearly illustrated in Fig. 3. The method of attaching this gate of four patterns to the frame is illustrated and the construction of the frame also is shown. The drag half of the mold is still on the machine, which is of the squeezer type.

The lifting of the flask is accomplished by four rollers mounted on shafts, located in the corners of the frame. When the molding frame is in position for raising the mold, the rollers are flush with the surface of the frame; turning the lever actuates the rollers which lift the cope flask and draw the pattern. The rollers contact with metal strips on the corners of the flask to insure a level bearing surface and one which will be subjected to the minimum amount of wear. The frame is provided with extensions on the four corners for rapping patterns by hand and an ear is on one of the handles for the attachment of a vibrator. The molding frame can be used with either straight or tapered flasks. The flask pins are furnished as a part of the equipment so that any flask can be equipped for operations with the frame.

The handles on the frame are adjustable to the pins with lock nuts, thereby insuring accurate draws and eliminating all possiblty of shifting. Aluminum matchplates can be used with this frame by attaching them to the top of the frame with screws. The frame has a draw of 1½ inches.

The plant of the Peerless Foundry Co., Hamilton, O., which specializes in light gray iron castings, is oper-



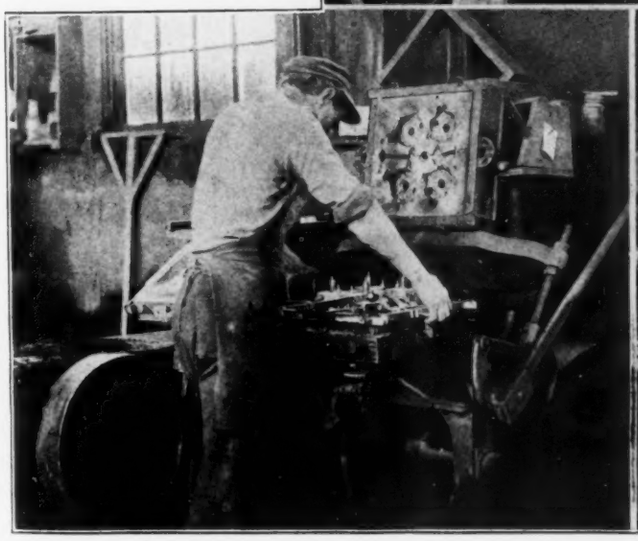


FIG. 1—DRAWING THE PATTERN BY THE USE OF A MOLDING FRAME WHICH LIFTS THE COPE BY TURNING THE LEVER AT THE FRONT

FIG. 2—COPE LIFTED OFF AND THE OPERATOR IS REMOVING THE FRAME FROM THE DRAG

FIG. 3—FRAME AND PATTERN READY TO PLACE ON THE MATCH-PLATE AFTER THE MOLD HAS BEEN COMPLETED

FIG. 4—LARGE OUTPUT OF UNSKILLED OPERATIVES WHO USE THE MOLDING FRAME

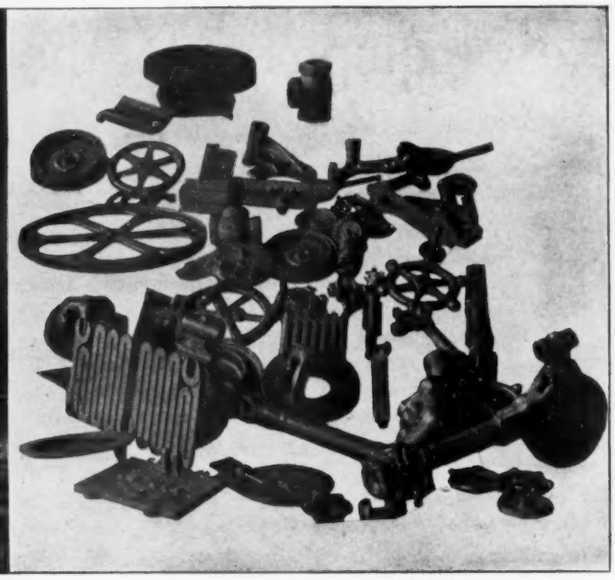


FIG. 5—MISCELLANEOUS CASTINGS MADE BY THE USE OF THE MOLDING FRAME

ated exclusively by this molding frame process. A wing of this foundry is shown in Fig. 4, the size of the floors being particularly noteworthy, since none of the men in this part of the shop had been engaged in molding more than one week when this photograph was made. It will be noted that all of the work in this department is made by the use of this molding frame. The wide variety of work that can be made by the use of this special frame is clearly illustrated in Fig. 5.

In addition to the molding frame shown, the New Foundry Appliance Co. manufactures flasks equipped with the adjustable pin and ear. The pins are machined inside and outside and are adjusted with lock nuts indicated at *A*, Fig. 6.

Screw Counting Machine

A machine used to count a definite number of screws and to deliver them into a package was recently developed by the Reynolds Pattern & Machine Co., Moline, Ill. It is used in hardware manufacturing plants, where it is necessary to pack a certain number of screws with each article sent out, these screws being used by the purchaser in assembling. In operating the machine, the package is set on a pad on the end of a lever located below a chute. When a lever is depressed, the proper number of screws slide down the chute into the package.

The Independent Pneumatic Tool Co., Chicago, is distributing a four-page folder, which illustrates and describes its line of portable electric drills and grinders. These tools consist of eight different sizes of electric drills with capacities ranging from ¼ to 2 inches and a portable electric grinder carrying a wheel, ¾ x 4 inches.

Develops Large Sand-Blast Barrel

In response to a demand for a sand-blast barrel of sufficient strength and size to clean heavy steel castings, the American Foundry Equipment Co., New York, has developed a machine which is larger than any of this type previously manufactured by this company. The drum or barrel proper is made of steel throughout and is securely riveted. It is 60 inches in diameter and 36 inches long, inside measurements. As the blast enters at each end of the drum, there are no projections on the interior and, therefore, castings can be loaded to within a few inches of the center line. This permits the handling of unusually large castings of medium weight in this machine.

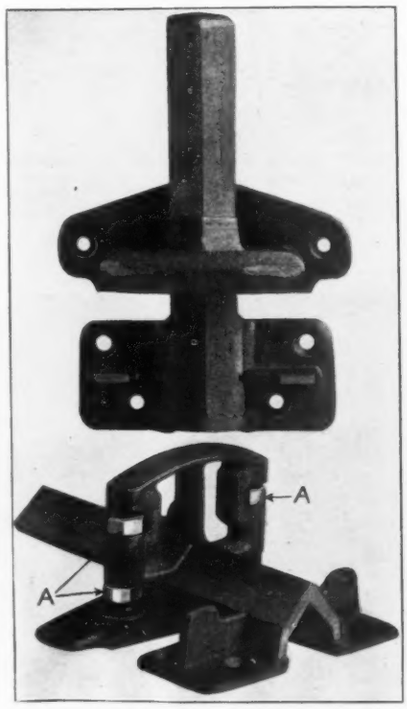


FIG. 6 — ADJUSTABLE PIN AND EAR WHICH IS A PART OF THE FLASK EQUIPMENT FOR THE USE OF THE MOLDING FRAME

The lower casing of the machine is made of heavy cast sections. The drum revolves on hardened machine steel rolls mounted on heavy shafting running in bronze bushings, the whole being supported on the frame by cast steel journal boxes. The casing above the journal is made of steel plate and structural shapes.

Removal of Dust

Provision is made in the casing for the removal of dust as soon as it is made, the air entering the casing through louvres in the doors. The machine is equipped with an underground pressure tank provided with a filling valve and air control sand trap, which automatically controls the operation of the blast when the machine is started or stopped.

The barrel is driven through worm gearing by a 3-horsepower motor, the entire outfit being a complete and self-contained unit. The machine requires a floor space of approximately 6 x 8 feet and when installed stands 8 feet above the floor level. The pit for the pressure tank is 5 feet 6 inches deep. The capacity varies through a wide range depending on the number and size of nozzles used, the pressure available and the material being sand-

blasted. Fig. 1 is a front view of the machine and Fig. 2 is a similar view with the doors open and the barrel door let down to charge or remove castings.

Personals

L. E. Marseau has been appointed superintendent of the foundry operated by the Gartland-Toledo Foundry Co., Toledo, O.

H. I. Landis has been elected president of the Lansdale Foundry Co., Lansdale, Pa., manufacturer of light and medium gray iron castings.

James Ferris has been made general superintendent of the Kenosha, Wis., plant of the Simmons Mfg. Co., succeeding Otto Rudd, who has been elected second vice president.

Carl H. Swartz, formerly superintendent of the foundry operated by the W. T. Rawleigh Mfg. Co., Freeport, Ill., has established a gray iron foundry in that city.

T. S. Bird, formerly superintendent of the foundry operated by the Michigan Motor Casting Co., Flint, Mich., has accepted the position of general superintendent of the new Ecorse Foundry & Machine Co., Ecorse, Mich.

L. W. Lukens recently resigned as superintendent of the Illinois Malleable Iron Co., Chicago, in order to accept the position of foundry superintendent of the new plant of the Saginaw Malleable Iron Co., Saginaw, Mich. In his new position, Mr. Lukens will be associated with C. F. Drozeski, general manager. Mr. Lukens, who is widely known among western foundrymen, was connected with the Illinois Malleable Iron Co. continuously for 24 years.

Charles Page Perin, consulting engineer, New York City, for about 16 years, and Stewart M. Marshall, formerly chief engineer of the Cambria Steel Co., Johnstown, Pa., and recently chief engineer of the Southwark Foundry & Machine Co., Philadelphia, have formed a co-partnership as consulting engineers, with offices at No. 2 Rector street, New York.

Inquiry by Subscriber

Under date of Feb. 19 an inquiry was received from one of the readers of *The Foundry* signed "Subscriber". asking for a substance that can be used in place of plaster of paris for making temporary patterns. If this subscriber will furnish his name and address we will give him information direct regarding the source from which this material can be purchased.

Trade Notes

The New York office of the Titanium Alloy Mfg. Co., Niagara Falls, N. Y., has been removed from 15 Wall street to the City Investing building, 165 Broadway.

The Union Smelting & Refining Co., Avenue D and Fourteenth street, New York, will erect a new plant on an 11-acre site on St. Charles street Newark, N. J. The plant ultimately will have five times the capacity of its present plant in New York City and will cost between $350,000 and $500,000. The first section of the new plant is expected to be completed in six or eight months. On its completion, the company will abandon its present plant in New York. The line of products will continue to include white metal alloys of all kinds.

The Associated Foundry Foremen of New York and vicinity will hold their next monthly meeting March 17, at 7:30 p. m., at the Hotel Chelsea, West Twenty-third street, near Seventh avenue, New York City.

The business of Cutter, Fletcher & Co., Inc., Boston, certified public accountants, has been transferred to the firm or Clinton H. Scovell & Co., industrial engineers, Boston, and the firm name has been changed to Scovell, Wellington & Co.

The Adams-Bagnall Electric Co., Cleveland, is completing the installation of a porcelain enameling plant. It consists of a battery of four 12-foot furnaces with the necessary complement of mixing vats, smelting furnaces, drying ovens, etc.

The Canton Metal Products Co., Canton, O., has taken over the business of the Canton Corrugating Co., and will engage in the manufacture of a complete line of sheet metal products, including foundry and factory equipment, such as shelving, bins, etc.

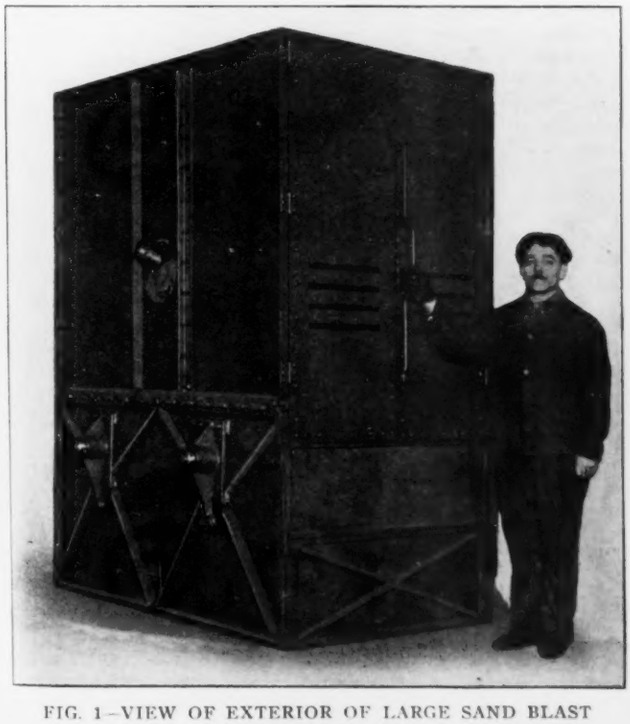


FIG. 1—VIEW OF EXTERIOR OF LARGE SAND BLAST BARREL

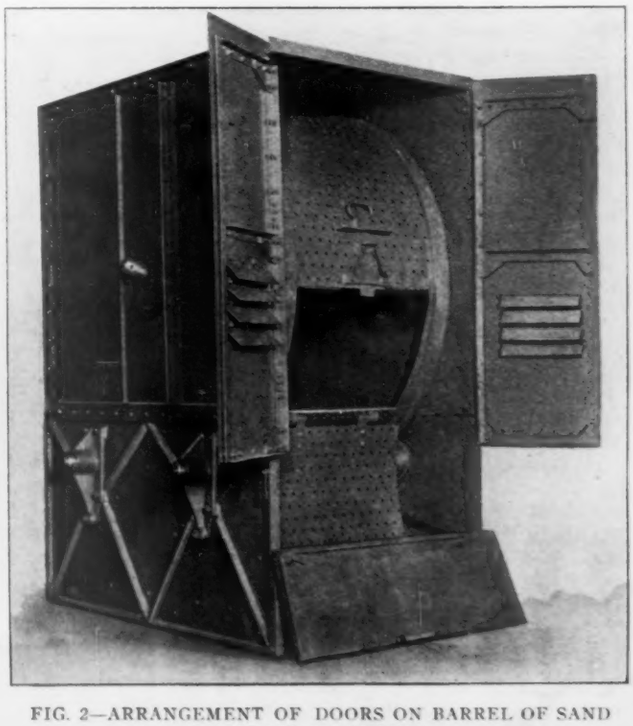


FIG. 2—ARRANGEMENT OF DOORS ON BARREL OF SAND BLAST MACHINE

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The foundry of the Mal-Gray Casting Co., Cambridge City, Ind., will be enlarged.

The Banner Foundry Co., Akron, O., will erect a steel foundry at 216 Newton street.

The Duquesne Reduction Co., Pittsburgh, contemplates building a foundry, 50 x 100 feet.

The Dixie Foundry Co., Cleveland, Tenn., is building a 60 x 120-foot addition to its plant.

The Saco-Lowell Shops, Lowell, Mass., will build a brick foundry addition, 125 x 168 x 170 feet.

The Buhl Malleable Co., Detroit, has increased its capital stock from $230,000 to $460,000.

The Ohio Mold & Foundry Co., Cincinnati, has increased its capital stock from $100,000 to $150,000.

Leslie V., John A. and C. H. Roake have incorporated the Oregon City Foundry with $20,000 capital.

The LaPoint Foundry Co., Schleisingerville, Wis., will build an 18 x 30-foot addition to its foundry.

Plans have been completed by the Central Foundry Co. for the erection of a 40-ton pipe plant at Bessemer, Ala.

The H. C. Macaulay Foundry Co., Berkeley, Cal., is building an addition to its plant at a cost of $40,000.

The Jakes Foundry Co., Nashville, Tenn., has been incorporated with $10,000 capital by Robert and J. W. Jakes.

The West Bend Aluminum Co., West Bend, Wis., contemplates the erection of a two-story, 50 x 260-foot addition.

Plans are being prepared for a 60 x 120-foot foundry to be erected for the Emerson Motor Co., Kingston, N. Y.

Plans are being drawn for a 60 x 240-foot foundry to be erected for the Caldwell Lawn Mower Co., Newburgh, N. Y.

The R. M. Eddy Foundry Co., 372 West Grand avenue, Chicago, has increased its capital stock from $150,000 to $200,000.

The East Bay Foundry Co., Oakland, Cal., recently incorporated with a capital stock of $20,000, will erect a gray iron foundry.

The Stubbs Foundry & Machine Co., Waco, Tex., will erect a foundry at a cost of $10,000, a pattern shop and a steel fabricating shop.

The Belleville Malleable Iron Foundry Co., Belleville, Ill., recently incorporated with $150,000 capital, will erect a malleable foundry.

The Valley Iron Works Co., Appleton, Wis., has increased its capital stock from $60,000 to $200,000 and will enlarge its plant.

The Dayton Malleable Iron Works, Ironton, O., will build two wings, extending the foundry 120 feet and the annealing room 150 feet.

A contract has been awarded by the American Radiator Co., Titusville, Pa., for the erection of an 80 x 100-foot addition to its foundry.

The Richmond Malleable Castings Co., Richmond, Ind., has been incorporated with a capital stock of $100,000. The officers of the company follow: John M. Lontz, president; H. R. Lontz, vice president and treasurer; W. J. Blackmore, secretary and general manager and G. B. Cavelage, superintendent.

The Taylor Coupler & Steel Castings Co., Toledo, O., has been incorporated with a capital stock of $100,000 by J. C. Taylor and L. S. Dukes.

The Framingham Machine Works, Framingham, Mass., is remodeling its plant into an iron foundry which will have an output of 60 tons daily.

The Empire Brass Mfg. Co., 8410 Lake avenue, Cleveland, will erect a brick and steel foundry at 10301 Berea road at a cost of $10,000.

The International Harvester Co. of New Jersey is building a 24 x 170-foot addition to its malleable foundry at 1734 Fullerton avenue, Chicago.

The City Brass Foundry Co., Detroit, has been incorporated with $2,000 capital stock by Frederick L. Maeder, Isaac Kaplan and H. H. Smilansky.

A contract has been awarded for the erection of a 150 x 200-foot addition to the foundry of the Davis & Furber Machine Co., North Andover, Mass.

The American Valve & Tank Co., Indianapolis, has completed plans for a foundry, 60 x 200 feet, to be erected at Fairmont, W. Va., at a cost of $35,000.

The Concord Foundry Co., Elkhart, Ind., has been incorporated with a capital of $50,000. The incorporators are J. G. Schacht, S. E. Schacht and Earnest A. Skinner.

The H. & H. Foundry Co., Stamford, Conn., has been incorporated with a capital of $20,000 by Benjamin Harris, John Hansen, East Port Chester, Conn., and C. P. Webb.

The Railway Supply & Equipment Co., Seward, Pa., has reopened its plant, which has been idle for two months. W. C. Greer has been appointed foundry superintendent.

The Clover Foundry has been incorporated to engage in a general foundry business with $50,000 capital stock. Charles S., Charles M. and H. W. Clover are the incorporators.

The Studebaker Corporation, Detroit, shortly will erect a continuous gray iron foundry, 140 x 450 feet, equipped with three cupolas, at its South Bend, Ind., plant.

The Youngstown Foundry & Machine Co., Youngstown, O., contemplates the purchase of a site on which to locate its two foundries which the company is considering merging.

Plans have been prepared for a large foundry to be erected by the National Malleable Castings Co., Cleveland. Approximately 3,500 tons of steel are to be used in its construction.

The Champion Foundry & Machine Co., Chicago, Ill., has been incorporated with a capital of $40,000 by A. E. Nelson, S. C. Larson and E. I. Kreamer, 7 South Dearborn street.

The Southern Machine & Foundry Co., Nshville, Tenn., has been incorporated with a capital stock of $35,000 by S. S. Warren, E. and S. Hartsfeld, C. A. Schneider and H. L. Scott.

The K. M. Brass & Aluminum Casting Co., 10611 Quincy avenue, Cleveland, has purchased 6½ acres on the Erie railroad on which it contemplates erecting a plant at a cost of $100,000.

A contract has been awarded by A. Allan & Son, 386 Greenwich street, New York, for the erection of a 50 x 180-foot foundry for the manufacture of non-ferrous metal alloys, at Harrison, N. J.

The McAdamite-Aluminum Co. has succeeded the United States McAdamite Metal Co., 57 Isabella avenue, Detroit, and will continue the foundry business of the old company under the same management.

The Bridgeford Mfg. Co., Louisville, has been incorporated with $184,000 capital stock to engage in the operation of a stove foundry. The incorporators are J. W. Campbell, George Leff and P. C. Doerhoefer.

The Detroit Brass Works, Detroit, has increased its capital from $400,000 to $500,000. The Detroit Valve & Fittings Co., which is taking over the former company, has increased its capital from $500,000 to $1,500,000.

The St. Louis, Iron Mountain & Southern railroad contemplates erecting a foundry at its shops at Argenta, Ark., for the manufacture of freight car parts and repairs. E. A. Hadley, St. Louis, is chief engineer.

The Atlas Foundry & Machine Co., Tacoma, Wash., is building a foundry addition, including a pattern shop, 40 x 225 feet. Additional ground has been purchased and further extensions will be made this year.

The Axelson Machine Works, Los Angeles, Cal., will build a plant including a foundry, 100 x 156 feet; machine shop, 75 x 125 feet; forge shop, 25 x 75 feet; pattern shop, 75 x 126 feet; pattern storage, 25 x 30 feet, and office building, 30 x 100 feet.

Plans have been completed for the erection of an ingot mold plant at West Middlesex, Pa., for the Valley Mold & Iron Co., Sharpsville, Pa. The plant will have a capacity of 100 ingot molds a day and is expected to be in operation within six months.

The United States Steel Casting Co., recently incorporated with $1,000,000 capital, has purchased the property of the National Steel Casting Co., New Cumberland, W. Va., and will build another plant. The officers of the new company are as follows: Samuel Ungeleider, president; Jacob Adolph, vice president; Ray Muslin, secretary and Ralph B. Cohen, treasurer.

The Harrison Steel Castings Co., recently incorporated with a capital stock of $300,000, will erect an open-hearth steel foundry on a 25-acre plot of ground at Murphysboro, Ill. Bids are being received on a foundry building, 260 x 180 feet and a cleaning department building, 160 x 140 feet. The company will install two 15-ton open-hearth furnaces, to be designed for either oil or powdered coal fuel, one 25-ton and one 10-ton crane, with a 70-foot span, in the foundry and one 10-ton crane, with a 55-foot span, in the cleaning room building. The officers are J. W. Harrison, president; R. J. Harrison, vice president and G. W. Harrison, secretary and treasurer. The general offices will be located at Attica, Ind., the Chicago office, 522 McCormick building and office and works at Murphysboro, Ill.